Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

MAY, 1956

TECHNOLOGY DEPT.

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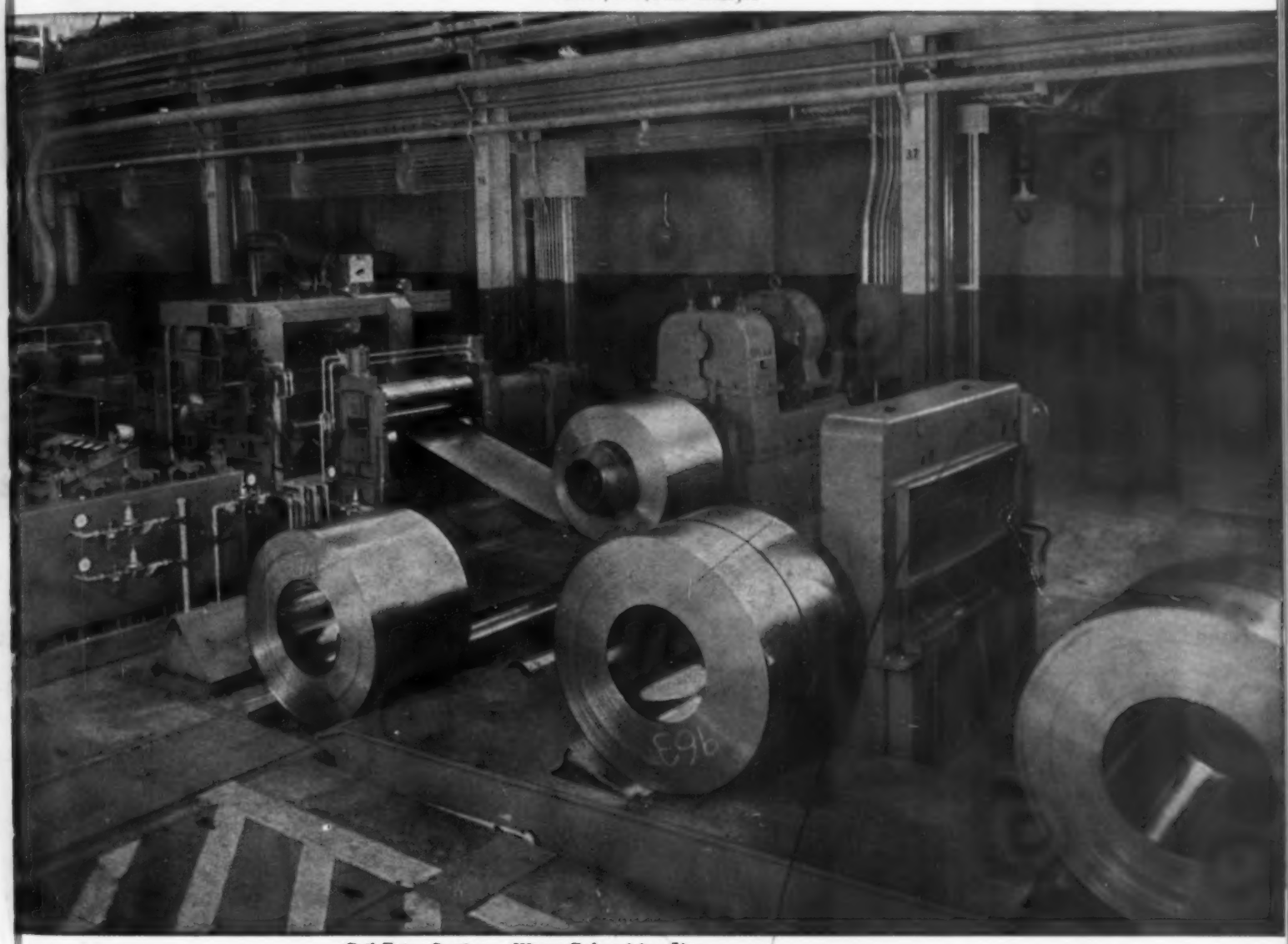

Coil Entry Section — Wean Galvanizing Line

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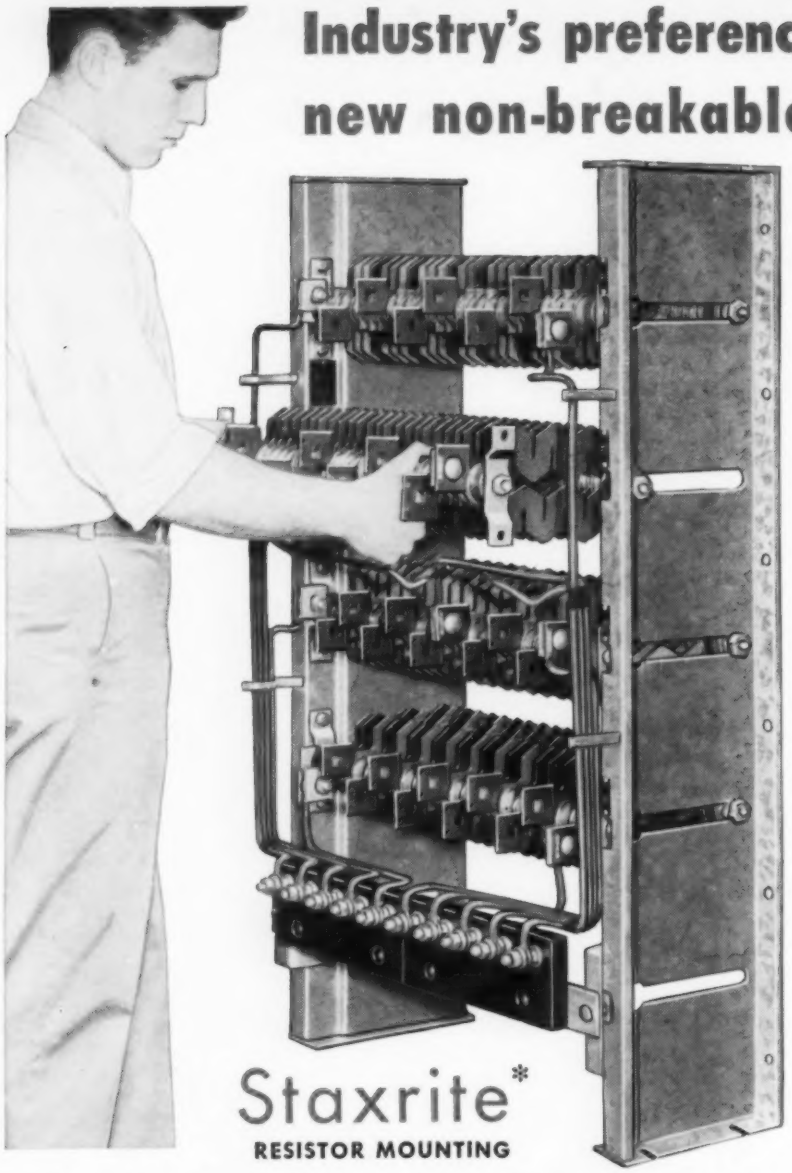
JUN - 5 1956
DETROIT

The WEAN ENGINEERING COMPANY · INC.
Warren, Ohio

Typical of Wean Advanced Engineering is this continuous hot dip galvanizing line that produces a vastly improved zinc coat steel at greatly increased speeds. Heavier coatings, tighter bonding and greater uniformity are now possible at reduced costs. It's this kind of never ending search for better ways of making better steel products that has established Wean as the nation's foremost designer and builder of sheet, tin and strip mill equipment.

SPECIALISTS IN SHEET, STRIP AND TIN MILL EQUIPMENT

Industry's preference... Cutler-Hammer's new non-breakable Mill Duty Resistor



Cuts costs during installation, maintenance and alterations. Exclusive C-H "Draw-out" designed resistor units slide in and out of position easily and quickly without disturbing the end frames, adjacent resistor units or mounting members. "Draw-out" design cuts costly "down time" to a minimum. If a resistor is damaged, simply draw out the damaged unit and slide in a spare.

Difficult resistor mounting problems made easy with Staxrite. Saves valuable space ... Staxrite mounting frame, available in graduated sizes up to nine resistor units high, only requires the floor area of one resistor box. Complete terminal board wired assemblies practically eliminate costly on-the-job wiring. Unwired assemblies also available.

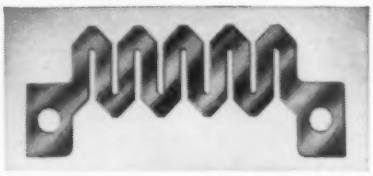
Exclusive "Draw-out" Design and Staxrite, the All New Resistor Mounting Frame, Have Made the Cutler-Hammer 11011 Mill Duty Resistors the Choice of Men Who Know

Cutler-Hammer, leading mill control designer and manufacturer for 63 years, is "first" again with "Draw-out" designed mill duty resistors and Staxrite, the multiple resistor mounting frame. Cutler-Hammer's 11011 resistor featuring exclusive "Draw-out" design, installs easier, works better and lasts longer.

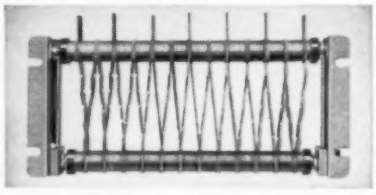
The C-H 11011 resistors are non-breakable, rugged, vibration proof, and corrosion proof. Staxrite, a new concept in resistor mounting, offers new savings in space . . . More resistor material for each square foot of floor area. Staxrite saves installation time. No more box-by-box mounting. For complete information on the C-H 11011 non-breakable resistor, Staxrite mounting frame and all types of mill duty control, write or wire today. Your inquiry will receive prompt attention.

CUTLER-HAMMER, Inc., 1269 St. Paul Avenue, Milwaukee 1, Wisconsin. Associate: Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

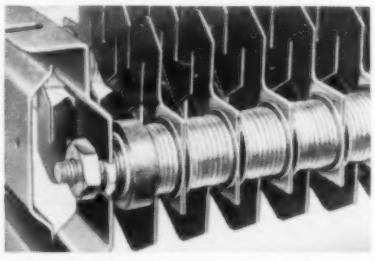
*Staxrite is a Cutler-Hammer Trademark



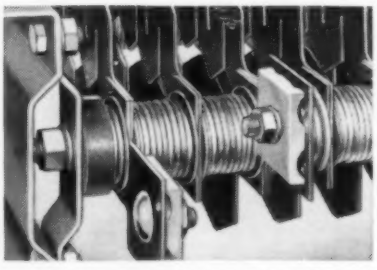
Accurate current and voltage regulation—Stamped chrome-steel grids (not cast) maintain a fixed, reliable resistance value... a must for machinery requiring precise regulation. Shock-proof, vibration-proof, corrosion-resistant and non-breakable.



Higher current capacities—Unique "over-under" grid pattern allows wider clearance between grids for maximum air circulation and rapid, sure heat dissipation. C-H resistors work harder. C-H resistors last longer.



More rugged but less weight—Welded grid joints form a rugged, continuous current path. No more heavy grid tie-rods. No more pressure dependent grid contacts. Note—New floating rod construction eliminates grid stresses and distortion due to thermal expansion.



Easy to wire terminals—Hefty projected terminals are staggered for wiring simplicity. Terminal-grid weld insures positive electrical contact—can't shake loose. Note the steel spacing washers and heavy-duty mica insulators... the mark of sturdy, rigid resistor construction.

CUTLER-HAMMER
MOTOR CONTROL
C-H

IRON AND STEEL ENGINEER; published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., Pittsburgh, Pa. Second class mail privileges authorized at Pittsburgh, Pennsylvania, January 25, 1924.

24

Aetna-Built

CONTINUOUS GALVANIZING LINES

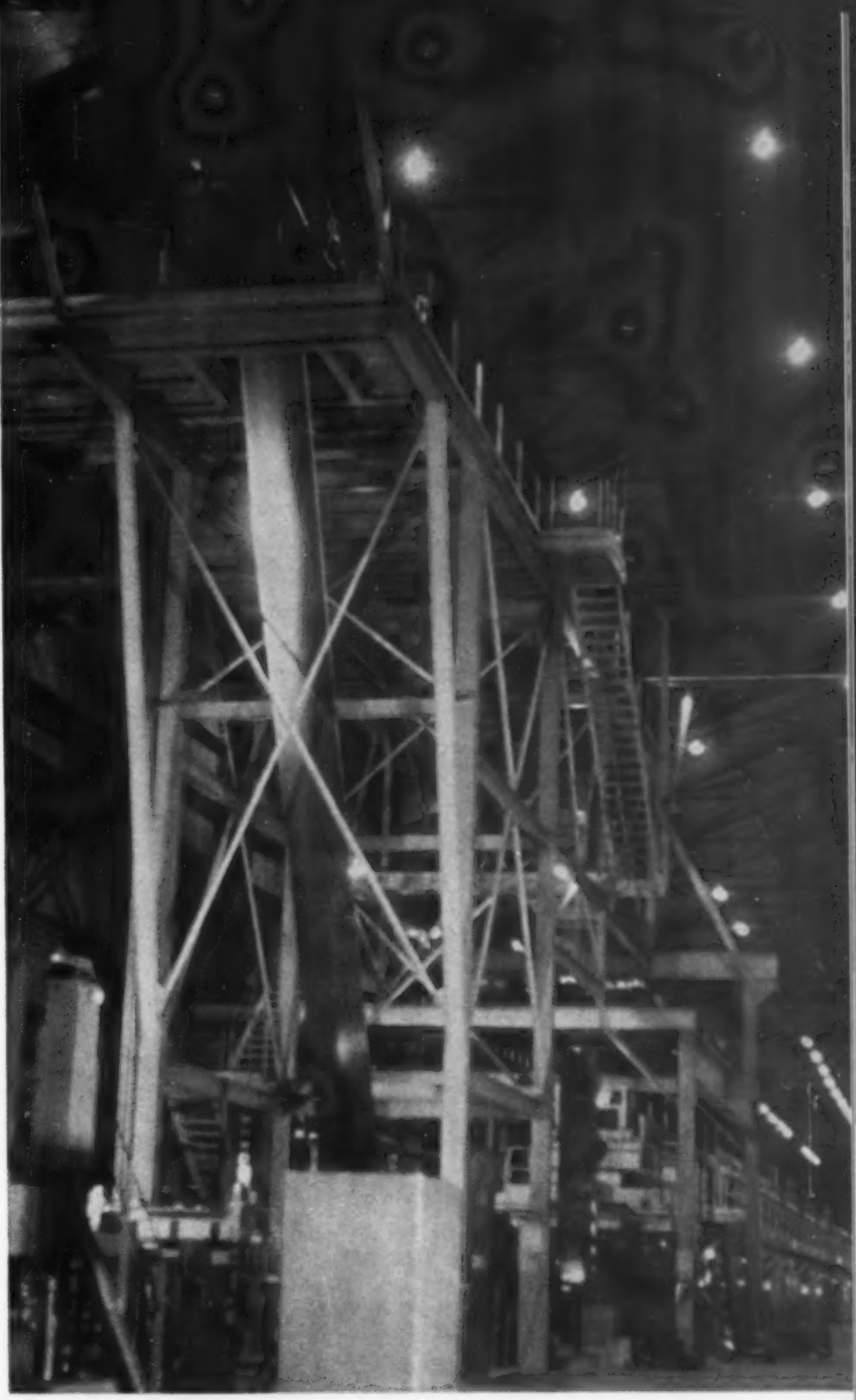
25th

UNDER WAY

WILL THE

26th

BE YOURS?



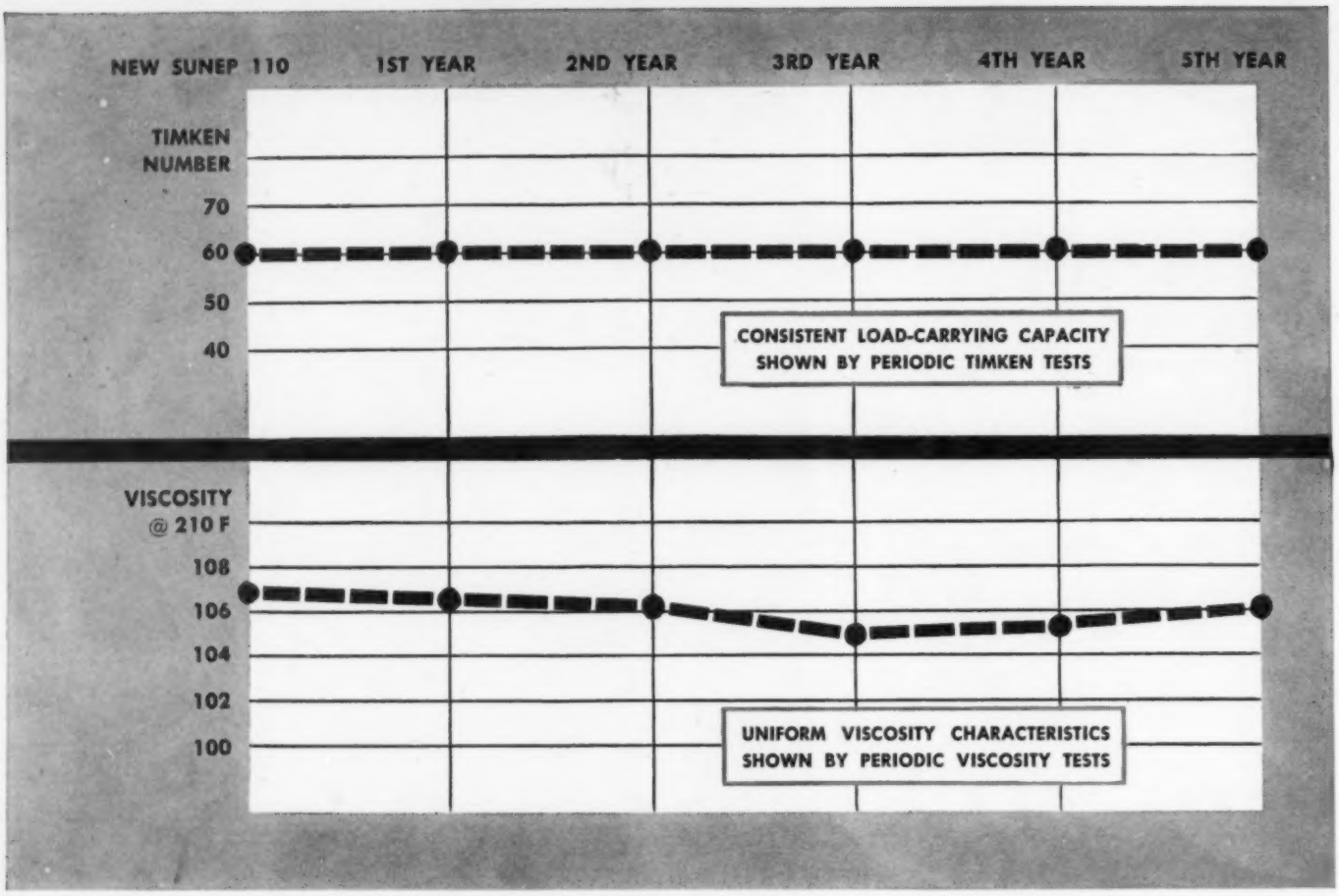
• The 26th line can be any process or type of Continuous Galvanizing in use today. Aetna-Standard has built more lines than all other manufacturers combined. If you are considering a continuous galvanizing line, Aetna has the facts, figures, production rates and other data on which you can base a sound decision. Why not make the 26th your line?

AETNA • STANDARD

THE AETNA-STANDARD ENGINEERING COMPANY

GENERAL OFFICES: PITTSBURGH, PA. **PLANTS: ELLWOOD CITY, PA., WARREN, OHIO**

CONTINUOUS GALVANIZING LINES • CONTINUOUS ELECTROLYTIC TINNING LINES • SIDE TRIMMING AND SHEAR LINES AND OTHER FINISHING EQUIPMENT • CONTINUOUS BUTT WELD PIPE MILLS • SEAMLESS TUBE MILLS • DRAWBENCHES AND OTHER COLD DRAW EQUIPMENT • ROLLS AND CASTINGS • EXTRUDERS, MILLS, PRESSES FOR RUBBER AND PLASTIC



Taken from the records of a major steel producer, the above graphs show the life record of a Sunep gear lubricant used in a 3-stand, 4-high cold-rolling mill. *With no make-up,* Sunep is as good as new after running more than 30,000 hours.

Steel company tests show:

SUNEP EXTREME-PRESSURE LUBRICANT REDUCES OIL AND MAINTENANCE COSTS

Sunep® lubricants help cut over-all oil costs because they have a long service life. They are made from high-quality base oils... unusual in the manufacture of extreme-pressure lubricants ...and because of this, are outstanding in their resistance to oxidation. They will not thicken or thin out in operation and will separate easily from water. Most important, they will last years longer than ordinary gear lubricants.

Sunep lubricants help keep maintenance down because they don't lose their e.p. qualities. They are specially blended to prevent "fall-out" of the extreme-pressure ingredients in service... a frequent and hidden cause of gear failure.

Sunep lubricants protect bearings and gears against rust and corrosion... an added help in reducing maintenance costs.

For complete information about Sunep lubricants see your Sun representative, or write for free Technical Bulletin 32. Address SUN OIL COMPANY, Philadelphia 3, Pa., Dept. IS-5.

SUNOCO®

INDUSTRIAL PRODUCTS DEPARTMENT

SUN OIL COMPANY Philadelphia 3, Pa.

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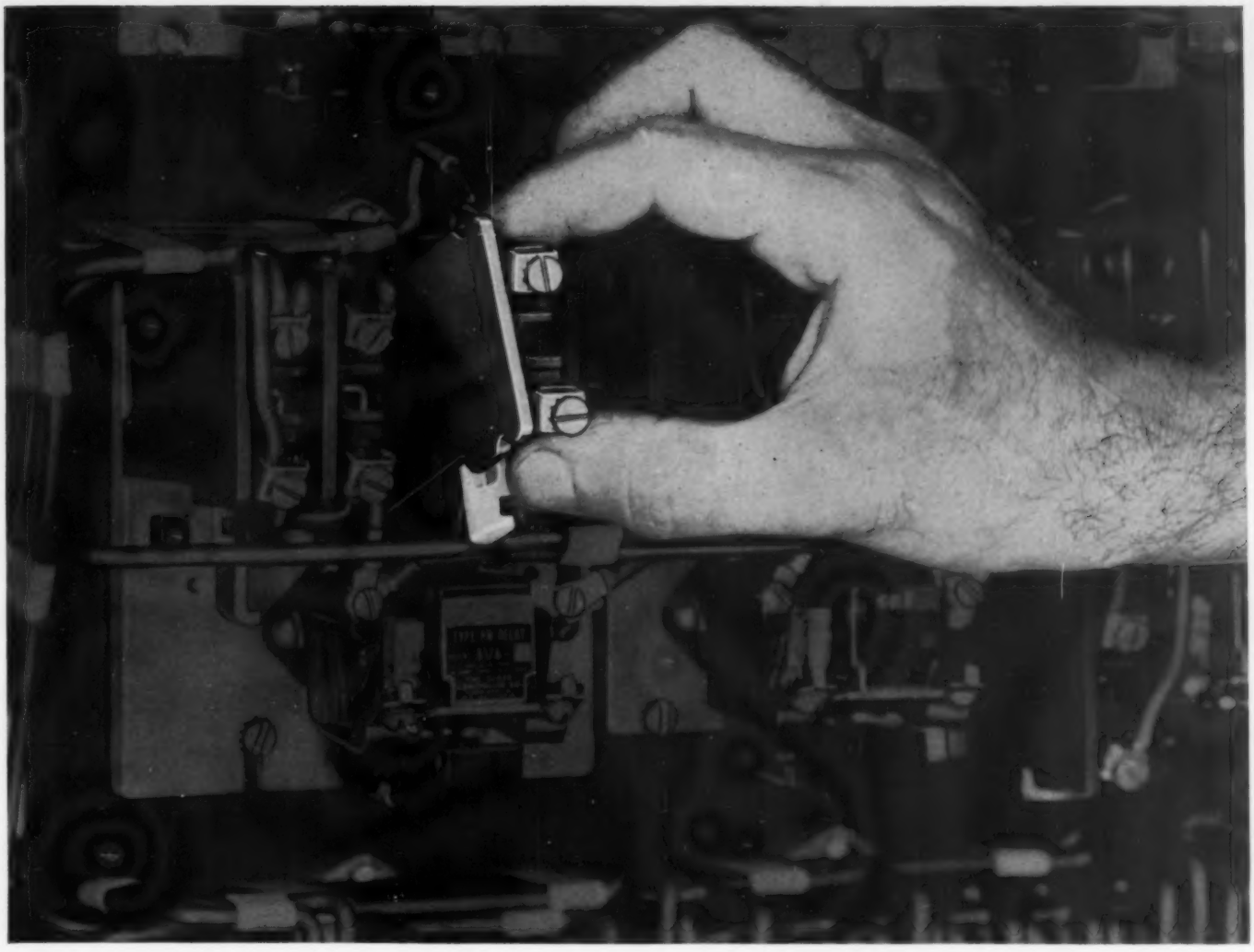
IN CANADA: SUN OIL COMPANY LIMITED, TORONTO AND MONTREAL

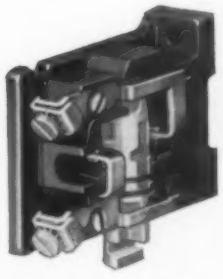


You can easily remove a single pole from any CLARK Type "PM" Relay

Each pole in the new CLARK heavy-duty relays is an integral unit that can be quickly removed or replaced *from the front* without disturbing other poles. You need disconnect only two wires and loosen one mounting screw—regardless of the number of poles in the relay. Compare this with other types of relays where the whole device must be removed to accomplish the same thing. For example, with a conventional 6 pole relay, 14 wires and 3 mounting screws must be removed.

All terminals are located on the front. They are "pressure" type, eliminating need for looping wire. Coil-changing and magnet replacement can also be done quickly from the front without removing relay from panel.

Write for Bulletin PL-7305



Each pole is contained in its own melamine housing.

A short circuit through one set of contacts is confined to a single pole and will not destroy the whole relay. Enclosed top protects from dust and dirt, and serves as wiring shelf.

The **CLARK CONTROLLER** *Company*

Engineered Electrical Control

1146 East 152nd Street • • Cleveland 10, Ohio

IN CANADA: CANADIAN CONTROLLERS, LIMITED • MAIN OFFICES AND PLANT, TORONTO

big industry, small world

annealing covers
billet reheating furnaces, continuous
carbon restoration and annealing furnaces, continuous
controlled atmosphere generators
high-speed stress relieving furnaces
one-way fired soaking pits
pit-type annealing furnaces
slab and billet heaters, continuous
strip annealing furnaces, continuous
strip galvanizing lines, continuous
wire patenting furnaces, continuous

Wherever this steel goes—from first soak to final shipping dock—it will find that the big steel industry is a small world as far as 'Surface' equipment is concerned. Somewhere along the line, whatever its destined shape, the steel will be made more workable and more useful in 'Surface' furnaces.

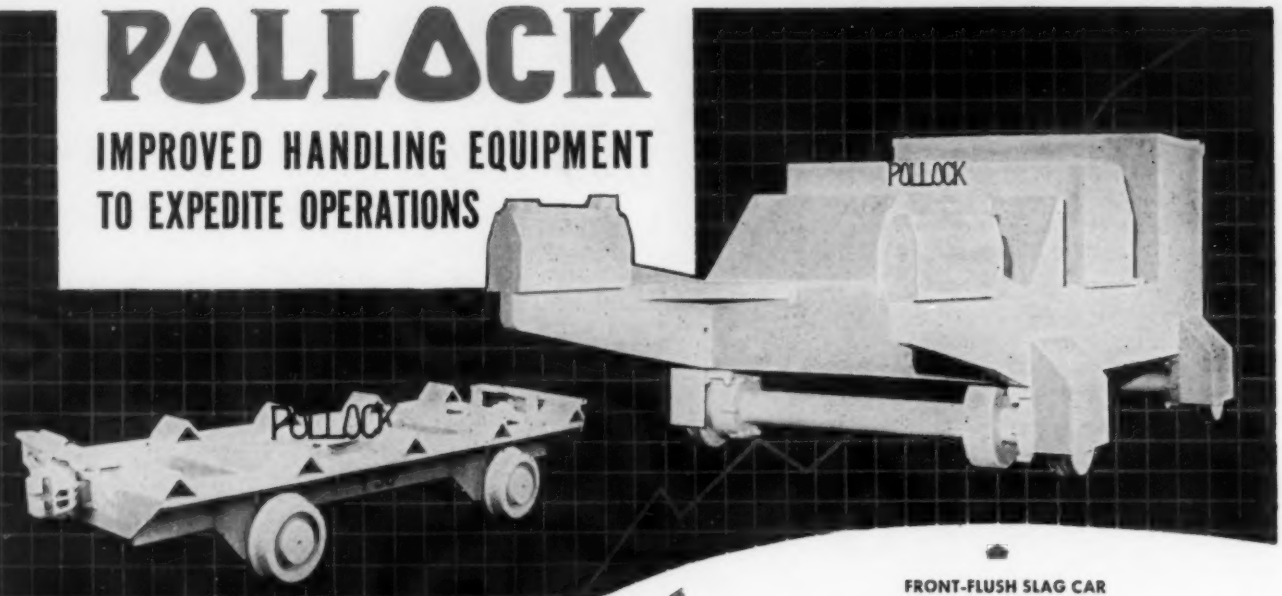
Why is it so easy to bump into 'Surface' in steel mills? One reason is that 'Surface' has literally grown up with the steel industry. A better reason is the confidence that steelmakers have in the performance of furnaces and generators manufactured by Surface Combustion Corp., Toledo 1, Ohio.

Surface
STEEL MILL FURNACES

Foreign associate companies:
British Furnaces, Ltd., Chesterfield; Stein & Atkinson, Ltd., London
Stein & Roubaix, Paris, Leige, and Genoa; Chugai Ro Kogyo Kaisha, Ltd., Osaka
Benno Schilde Maschinenbau, A.G., Bad Hersfeld (Hessen, Germany)

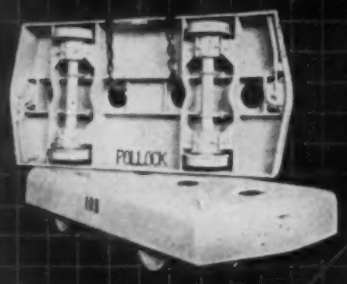
POLLOCK

IMPROVED HANDLING EQUIPMENT TO EXPEDITE OPERATIONS



FRONT-FLUSH SLAG CAR

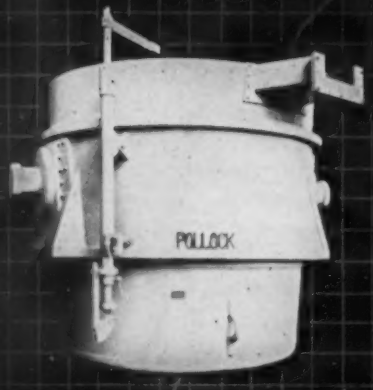
CHARGING BOX CAR



INGOT CAR

an important factor in increased open hearth production

OPEN HEARTH LADLE

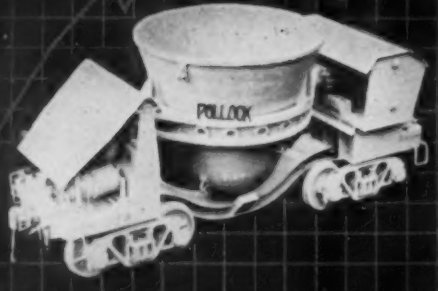


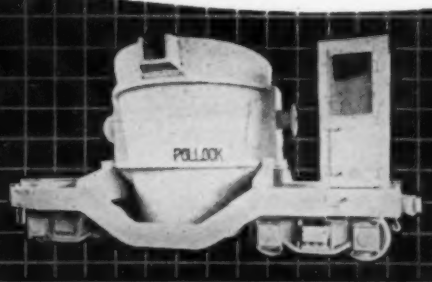
• Pollock experience in the development and construction of open hearth equipment assures smooth flow of operations. To measure use-value of Pollock handling equipment, add their day by day engineering research to 85 years of producing for the steel industry. General specifications available on request. Special-performance details engineered for your needs.

SLAG CAR

DRAG-OUT SLAG CAR

HOT METAL TRANSFER CAR





POLLOCK
SINCE 1863

THE WILLIAM B. POLLOCK COMPANY
YOUNGSTOWN · OHIO
STEEL PLATE CONSTRUCTION · ENGINEERS · FABRICATORS · ERECTORS

BLAST FURNACES · HOT METAL CARS AND LADLES · CINDER AND SLAG CARS · INGOT MOULD CARS · CHARGING BOX CARS · WELDED OPEN HEARTH LADLES

PRESENTING...

the NEW LINK-BELT MOTOGEAR

for bracket-mounting all foot-type NEMA motors—all makes and enclosures

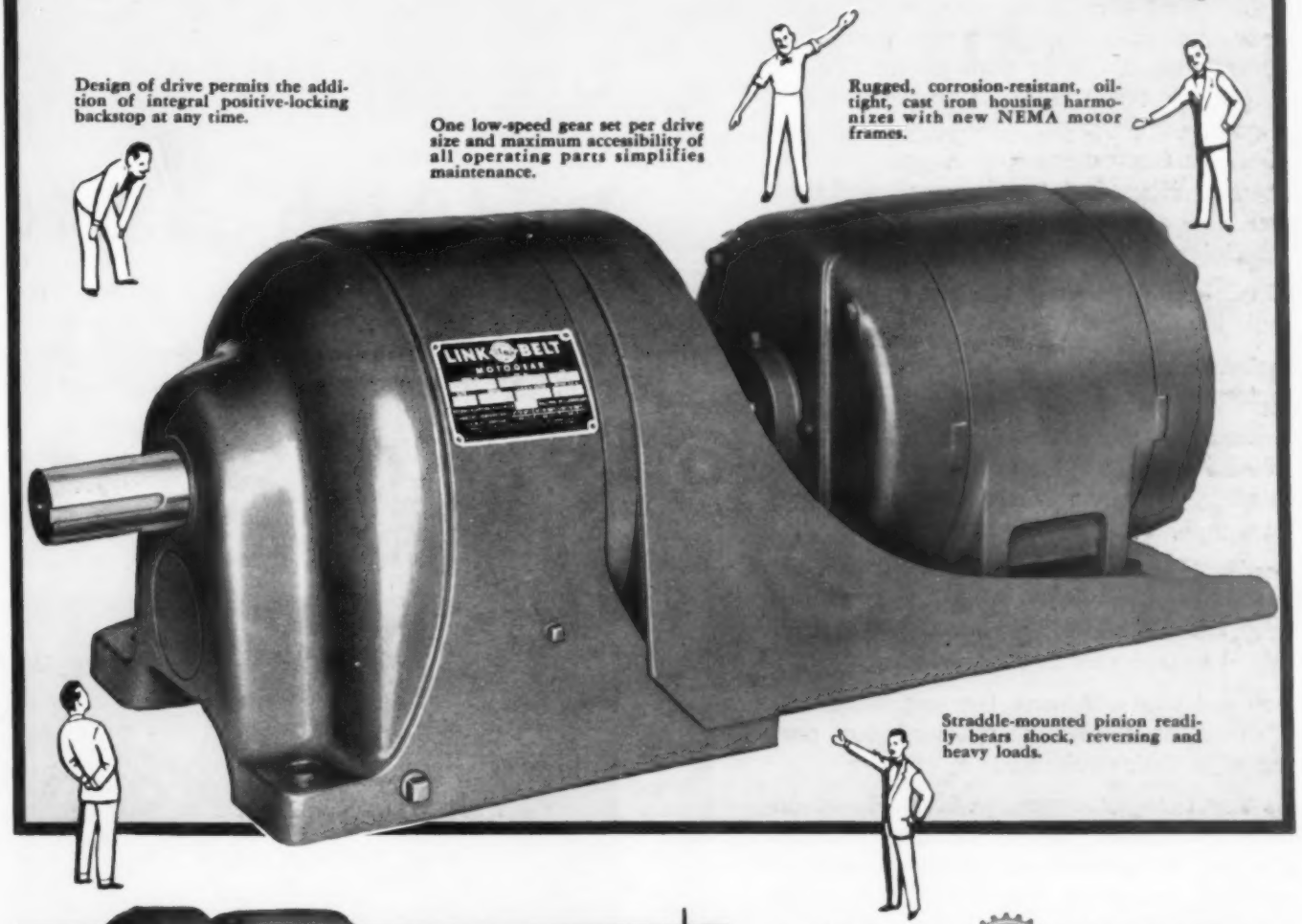
If drives in your plant operate continuously, the dependability of Link-Belt Motogears provides a sure means of minimizing costly, production-crippling downtime. Replacing a motor is simple and easy: just remove four bolts and separate the coupling—no need to drain oil. And design of the bracket assures rapid motor realignment. Sizes up to 60 hp; ratios from 6.2:1 to 292:1.

These are just a few of many advances in design you'll find detailed in 28-page Book 2447. Get a copy now from your nearest Link-Belt office or authorized distributor of Link-Belt products.

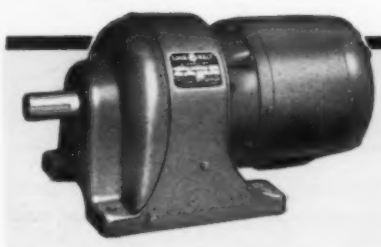
Design of drive permits the addition of integral positive-locking backstop at any time.

One low-speed gear set per drive size and maximum accessibility of all operating parts simplifies maintenance.

Rugged, corrosion-resistant, oil-tight, cast iron housing harmonizes with new NEMA motor frames.



Straddle-mounted pinion readily bears shock, reversing and heavy loads.



The new, improved Link-Belt line also includes compact Gearmotors with flange-mounted NEMA motors combining flexibility with outstanding design innovations.

LINK-BELT

ENCLOSED DRIVES

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13,899

Frequent Instrument Check-ups Prevent Emergencies

The economical way to protect your plant's investment in instrumentation is a Honeywell Periodic Service Plan. Under this plan, a Honeywell service specialist comes to your plant at regular intervals to—

— Check your Brown instruments and calibrate them against accurate laboratory standards.

— Inspect all moving parts, clean and lubricate them, and replace where necessary.

You get this kind of service performed regularly for your office equipment such as typewriters and calculating machines . . . for your automobile . . . and even for yourself by periodic check-ups by your doctor. You've learned that the ounce of prevention is a good investment. Well, the same philosophy applies to instruments, too. Keeping them in good condition is far more economical than waiting for emergencies to throw production schedules into a tailspin.

Here, briefly, is what the Honeywell Periodic Service Plan does. It provides you—

Periodic examination and adjustment by a factory-trained service engineer.

Automatic attention. Calls are made on a schedule that fits your own plant's requirements . . . at a cost substantially lower than an equivalent emergency service call.

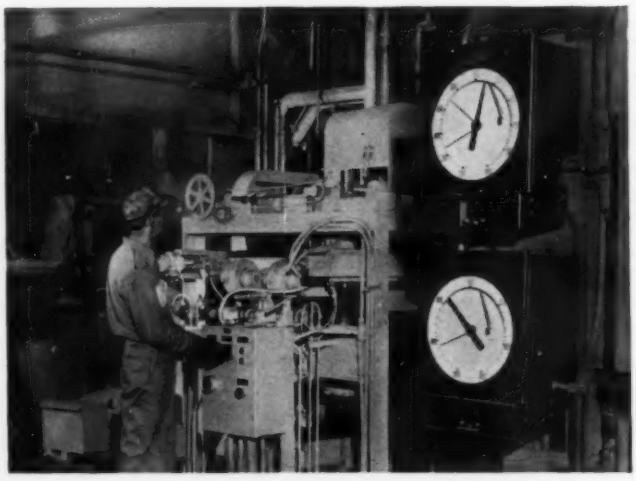
Continuous operation. Good instruments kept in top condition can be counted on for steady duty, without costly shut-downs. Well-maintained instruments last longer, too.

Increased plant efficiency. Greater reliability of operation builds confidence of plant personnel in their equipment.

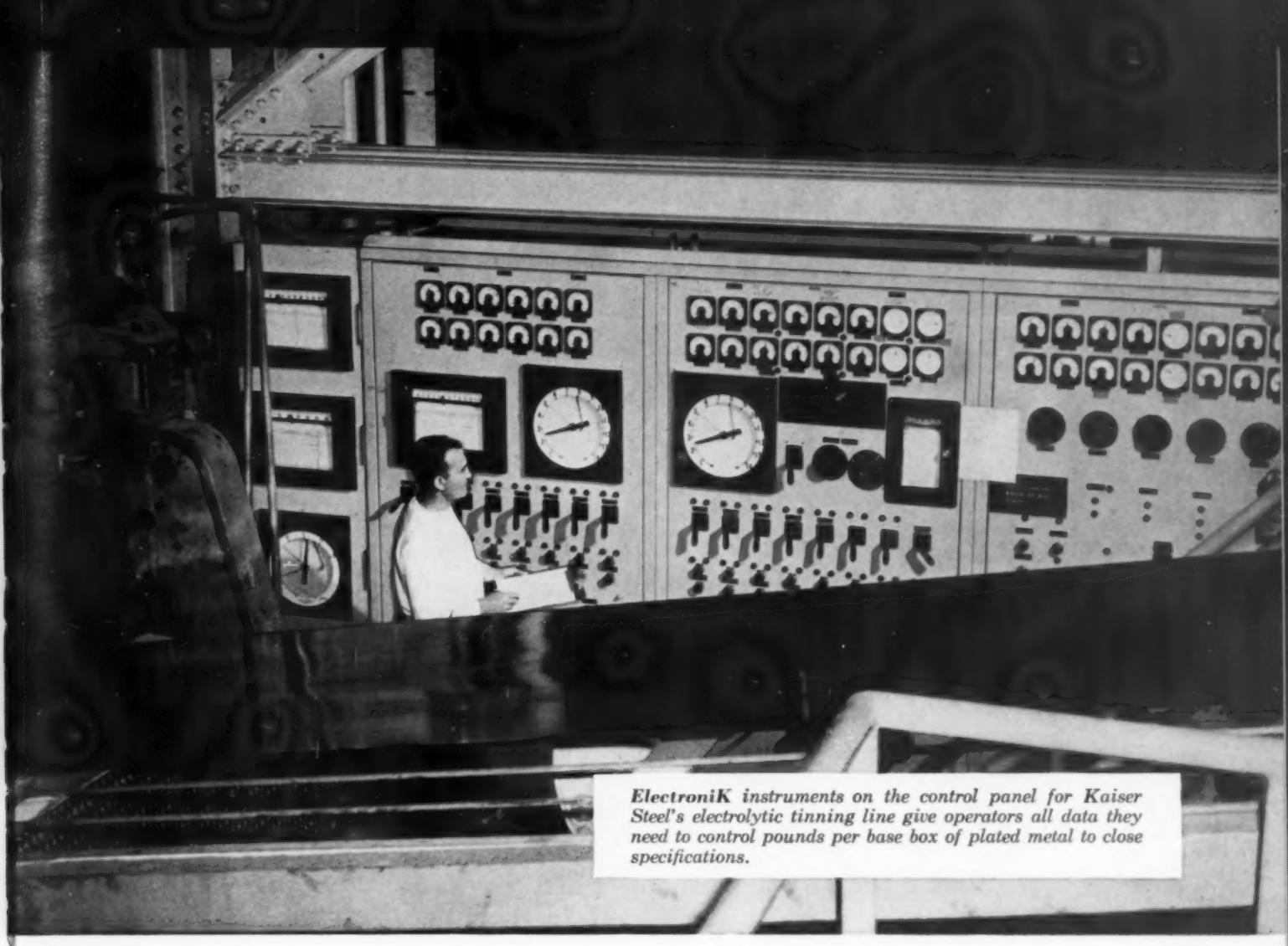
At any time, of course, you can count on prompt emergency service from any one of the more than 100 Honeywell service centers spotted throughout the United States and Canada.

The Plan is extremely simple. It costs remarkably little, and can pay real dividends in protection of your production schedules and your instrument investment. For details about how it can be applied to your own plant, call your local Honeywell office.

Kaiser Steel's tinning lines hold high quality and economy . . .



On control panel for hot dip tinning process are ElectroniK instruments for regulating temperatures of dip metal and oil bath.



ElectroniK instruments on the control panel for Kaiser Steel's electrolytic tinning line give operators all data they need to control pounds per base box of plated metal to close specifications.

with *ElectroniK* controls

KEEPING high-capacity production equipment operating at peak economy—while maintaining high standards of quality—is an assignment where modern Honeywell instrumentation proves a profitable investment. On tinning operations at Kaiser Steel's Fontana Mill, for example, Brown controls are helping to improve quality and uniformity of plated products.

For the electrolytic tinning line, designed by The Wean Engineering Company, control was engineered by General Electric and R&S Equipment Company. The central instrument panel concentrates complete data on the process for the line operators. At a glance, they can note critical plating currents, coating distribution and top and bottom pounds per base box . . . all recorded in detail on *ElectroniK* instruments. This information guides operators in holding weight of plating to exact specifications . . . reducing rejects . . . and achieving maximum utilization of electric power and plating materials.

On the hot dip tinning installation, also designed by Wean, temperatures are held within close limits by *ElectroniK* instruments with *Electr-O-Line* proportioning control. Accurate temperatures of the molten metal bath make it possible to control the thickness of tin coatings and to avoid waste of metal. Improved quality and smoother surfaces on finished plate result from precise control of oil bath temperatures.

Throughout the steel industry, Brown instruments have proved their ability to aid in making better products more economically. A complete line of instrumentation, developed and applied by men who know the needs of steel production, is ready to serve you. For a discussion of your specific requirements, call your local Honeywell sales engineer . . . he's as near as your phone.

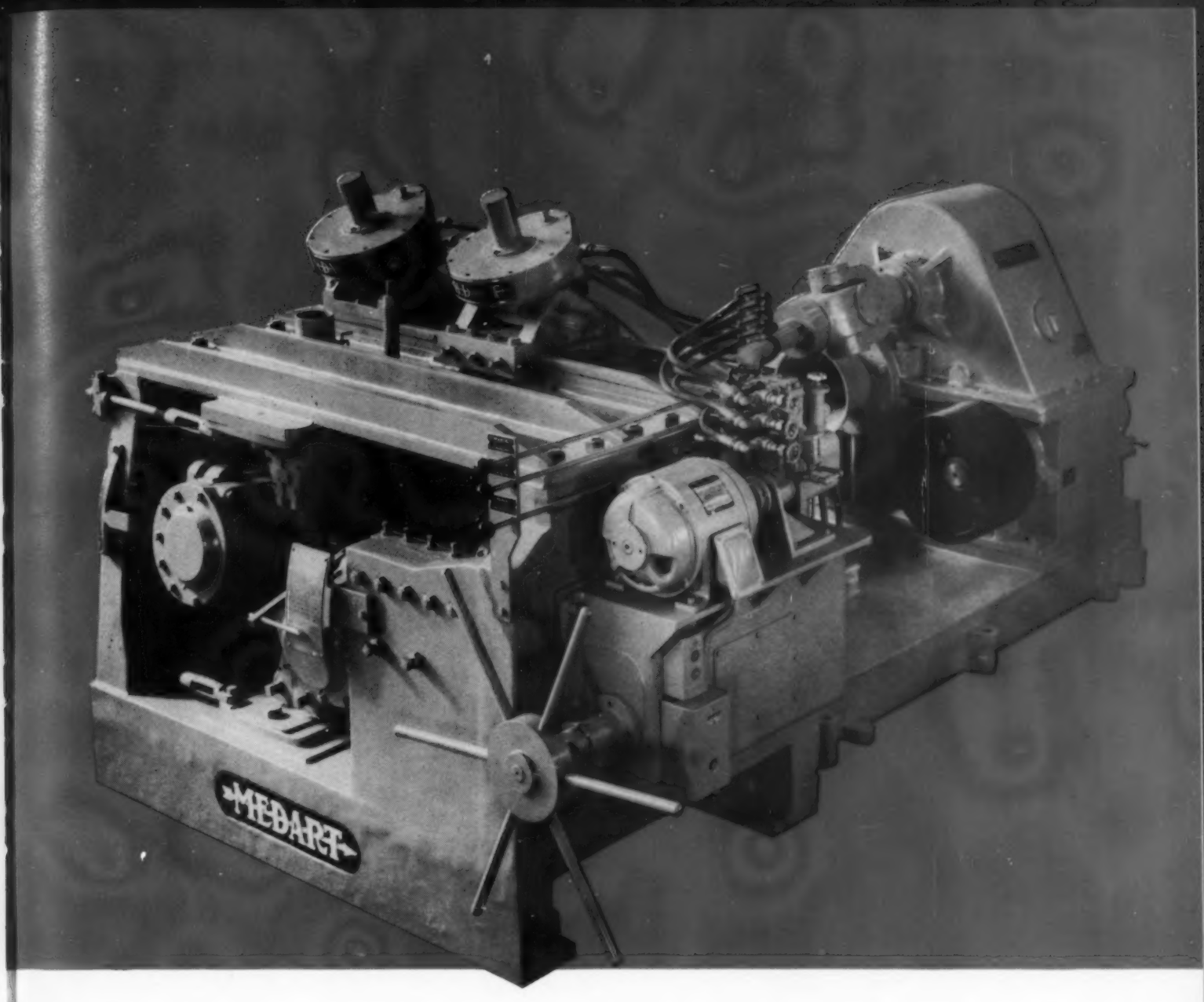
MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

● **REFERENCE DATA: Write for Catalog No. 1521, "*ElectroniK* Recorders" . . . and No. 1531, "*ElectroniK* Controllers"**

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

20 years of LEADERSHIP

BLOOM ENGINEERING CO., INC., 857 W. North Ave., Pittsburgh 33, Pa.



BLAW-KNOX MEDART makes what it takes

for continuous, high speed straightening, sizing and polishing

You can meet the most rigid requirements for cold finishing round bars, pipes and tubes with a Blaw-Knox Medart 2-roll Rotary Straightener. Designed to perform with the greatest accuracy, it straightens, "super-finishes," and corrects out-of-roundness in one operation.

Processing begins the instant the workpiece enters the rolls and continues right up to the very end. Because of this you can straighten short lengths as well as longer standard mill lengths. A modified straight roll then deflects the workpiece into the concave roll giving it a tremendous number of straightening cycles per foot, assuring precision straightening and sizing.

And this highly accurate finishing can be delivered at throughput speeds up to 350 ft/min. Operation is continuous by means of end-to-end feeding. The drive motor can be reversed with the bar between rolls to permit additional passes for sizing and polishing.

The speed, versatility, and accuracy of Blaw-Knox Medart 2-roll Rotary's have made them the standard of the industry. Available in ten sizes, they can handle workpieces from ⅛" to 9" diameter. Contact us for detailed information, technical assistance or service.

50th Anniversary
BLAW-KNOX
1906-1956

BLAW-KNOX COMPANY
Foundry and Mill Machinery Division
Blaw-Knox Building • 300 Sixth Avenue
Pittsburgh 22, Pennsylvania

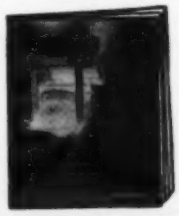
CONTINENTAL

INDUSTRY'S FIRST OXYGEN CONVERTERS

fabricated by Pennsylvania Engineering Corporation

The first top blown oxygen steel converters in the United States were fabricated by PECor for McLouth Steel Corporation. Completely assembled, aligned and operated in our shops before shipment, they feature greatly increased efficiency in the tilting mechanism and drives, precision cut gearing, anti-friction bearings and rugged, extra heavy-duty design throughout.

Whether your needs involve steelmaking or non-ferrous smelting or refining, handling of hot metal, slag, cinders or other metal production operations, depend on PECor—a new symbol for Pennsylvania Engineering Corporation's more than 75 years of experience in engineering and building top-quality equipment for the metal producing industries.



WRITE for complete PECor catalog.

PECOR

PENNSYLVANIA ENGINEERING CORPORATION

NEW CASTLE, PENNA.

OTHER STEEL PLANT EQUIPMENT WE BUILD

Blast Furnaces . . . Open Hearth Furnaces . . . Hot Metal Mixers . . . Hot Metal Mixer Cars . . . Ladles . . . Ladle Transfer Cars . . . Scrap Cars . . . Slag Cars . . . Ore Transfer Cars . . . Thermo Metal (Bottle) Cars . . . Jack Cars . . . Ingot Cars

ENGINEERS • FABRICATORS • ERECTORS

VICTOR R. BROWNING
MILL TYPE CRANES
to Specification..

Basically designed as required by A.I.S.E. specifications, mill type cranes built by Victor R. Browning & Co., Inc. also offer the opportunity of specifying preferences and standards prevailing in the purchaser's plant. May we have your next inquiry?

VICTOR R. BROWNING & COMPANY, Inc.
WILLOUGHBY (CLEVELAND), OHIO
DESIGNERS AND BUILDERS OF ELECTRIC OVERHEAD TRAVELING CRANES AND HOISTS AND ELECTRIC REVOLVING CRANES

SECOND IN THE SERIES

Customer's Report

"Lee Wilson 'O' Tube Heat Application Assures Quality Annealing"

Only in the Lee Wilson single stack furnace is the heat applied uniformly around the circumference of the charge and properly distributed in the vertical direction. Such heat application results in the most effective use of the heat available. As one customer recently stated — "I am convinced that the Wilson 'O' tube heat application assures quality annealing."

It is this type of heat application in the Wilson single stack furnace with a temperature control for every stack of steel that enables the operators to maintain exacting control of the temperature throughout the entire annealing period.

Only Lee Wilson Furnaces Give You All These Advantages

1. **GREATER FLEXIBILITY**
2. MORE UNIFORM HEAT APPLICATION
3. **IMPROVED CUSTOMER SERVICE**
4. **HIGHER PRODUCTION**
5. **BETTER LOAD FACTOR**
6. **MINIMUM PROCESS INVENTORY**
7. **REDUCED LABOR COST**
8. **BETTER OPERATING CONDITIONS**
9. **LOWER MAINTENANCE COST**
10. **REDUCED INSTALLATION COSTS**

Lee Wilson* **ENGINEERING COMPANY, INC.**

2005 WEST LAKE ROAD • CLEVELAND 16, OHIO

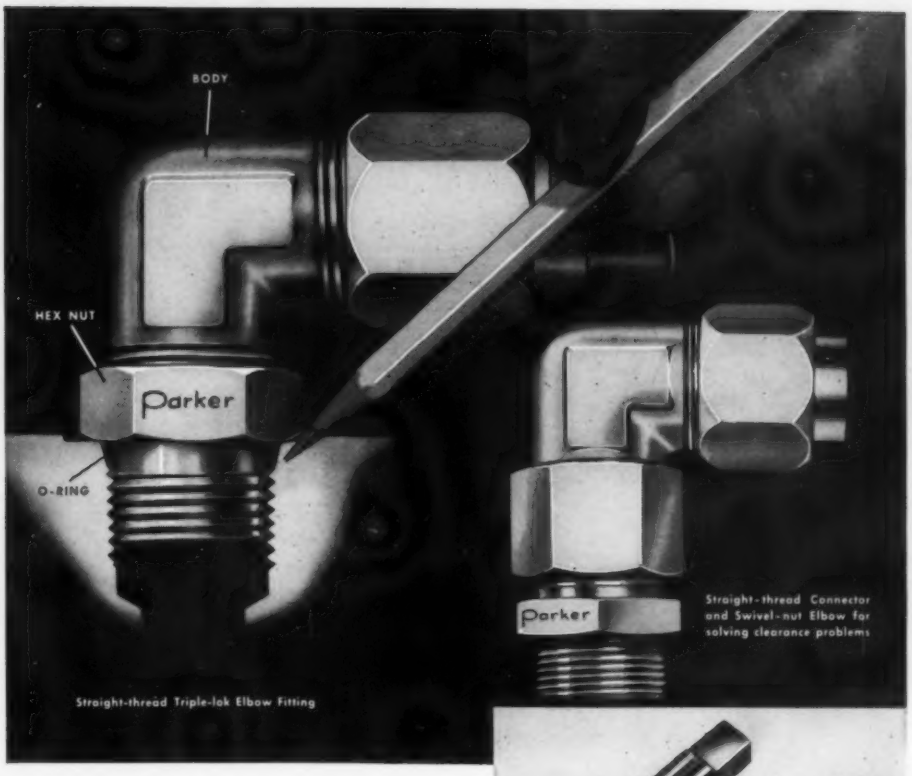
SINGLE-STACK RADIANT TUBE ANNEALING FURNACES

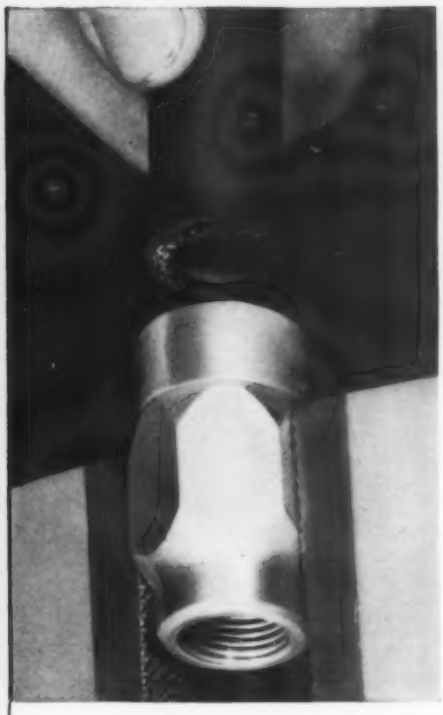
MAKE THE BEST METALS BETTER

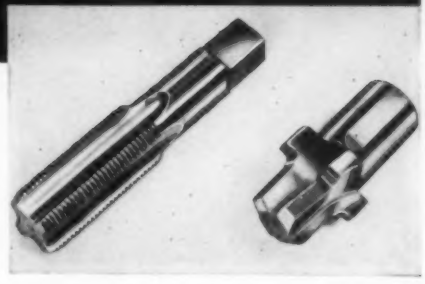
* ORIGINATORS AND LEADING PRODUCERS OF SINGLE-STACK RADIANT TUBE FURNACES

9919

The trend is to single stack, one of the nation's largest annealing departments recently set into operation 24 Lee Wilson Single Stack Furnaces and 72 bases.







Precision thread-tapping and counterboring tools for making accurate *straight*-thread boss (to receive these new Parker *straight*-thread fittings) are now available with machining drawings from Parker.

New Parker *straight*-thread fittings solve your leakage problems

Now you can forget about high-pressure hydraulic problems resulting from tapered pipe threads. Forget about leakage . . . about the danger of cracking or distorting valve bodies by over-tightening the fittings . . . about damaged threads from over-tightening to obtain proper positioning. Forget about messy pipe "dope".

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Use new Parker NO-SKIVE fittings

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Two simple steps complete the make-up: (1) Dip end of hose in oil and screw into socket counter-clockwise until hose reaches end of recess in socket. (2) Dip nipple in oil and push into socket and hose, turning clockwise to engage thread. Screw all the way in.

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☐ Please send me your new Bulletin 4402 about NO-SKIVE Parker Hoze-lok fittings.

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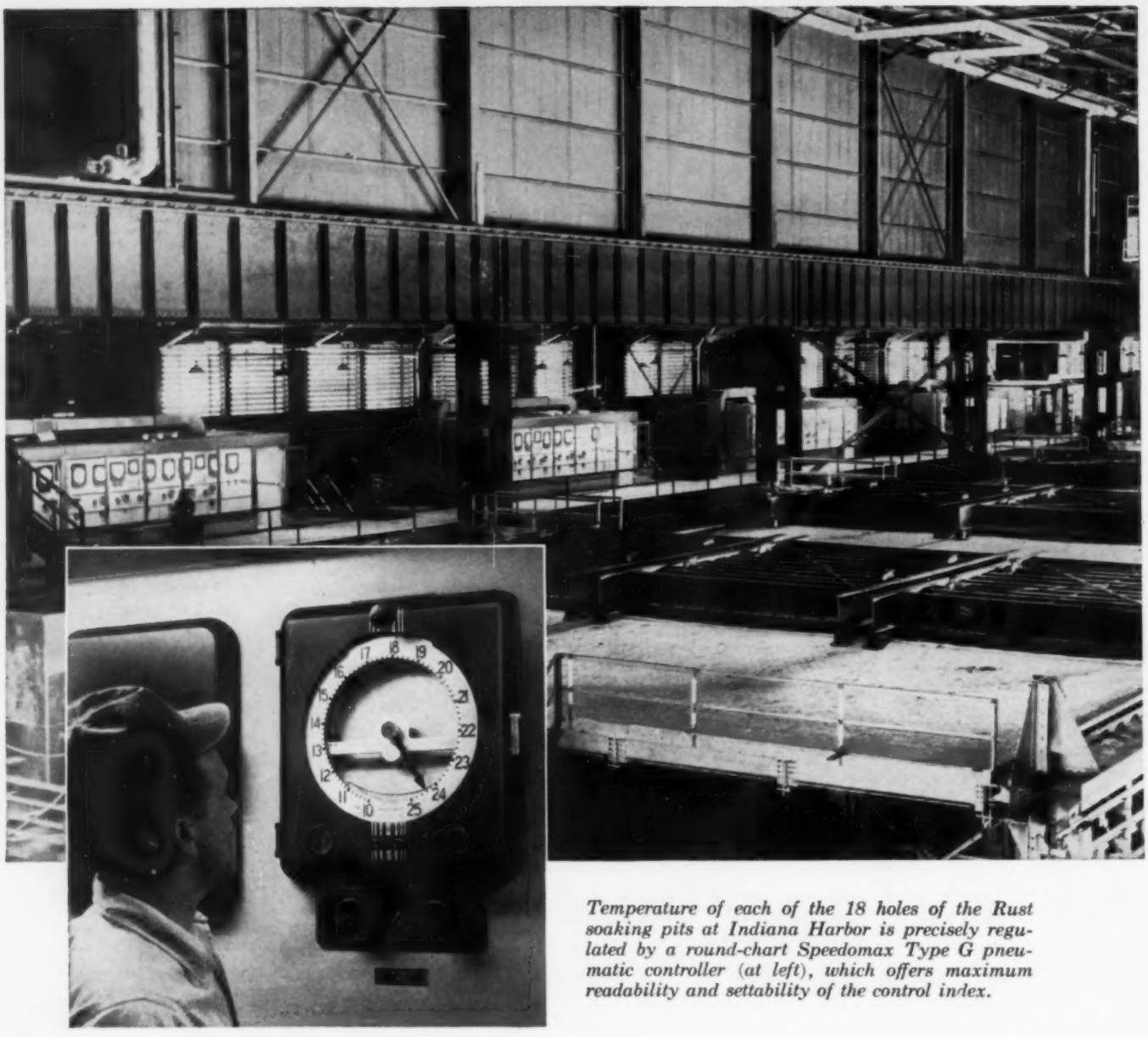

Temperature of each of the 18 holes of the Rust soaking pits at Indiana Harbor is precisely regulated by a round-chart Speedomax Type G pneumatic controller (at left), which offers maximum readability and settability of the control index.

At Indiana Harbor Works, too Youngstown Sheet & Tube installed Speedomax®

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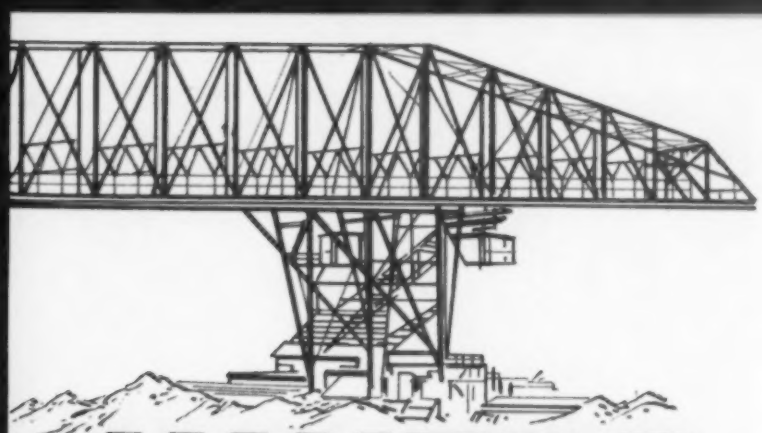

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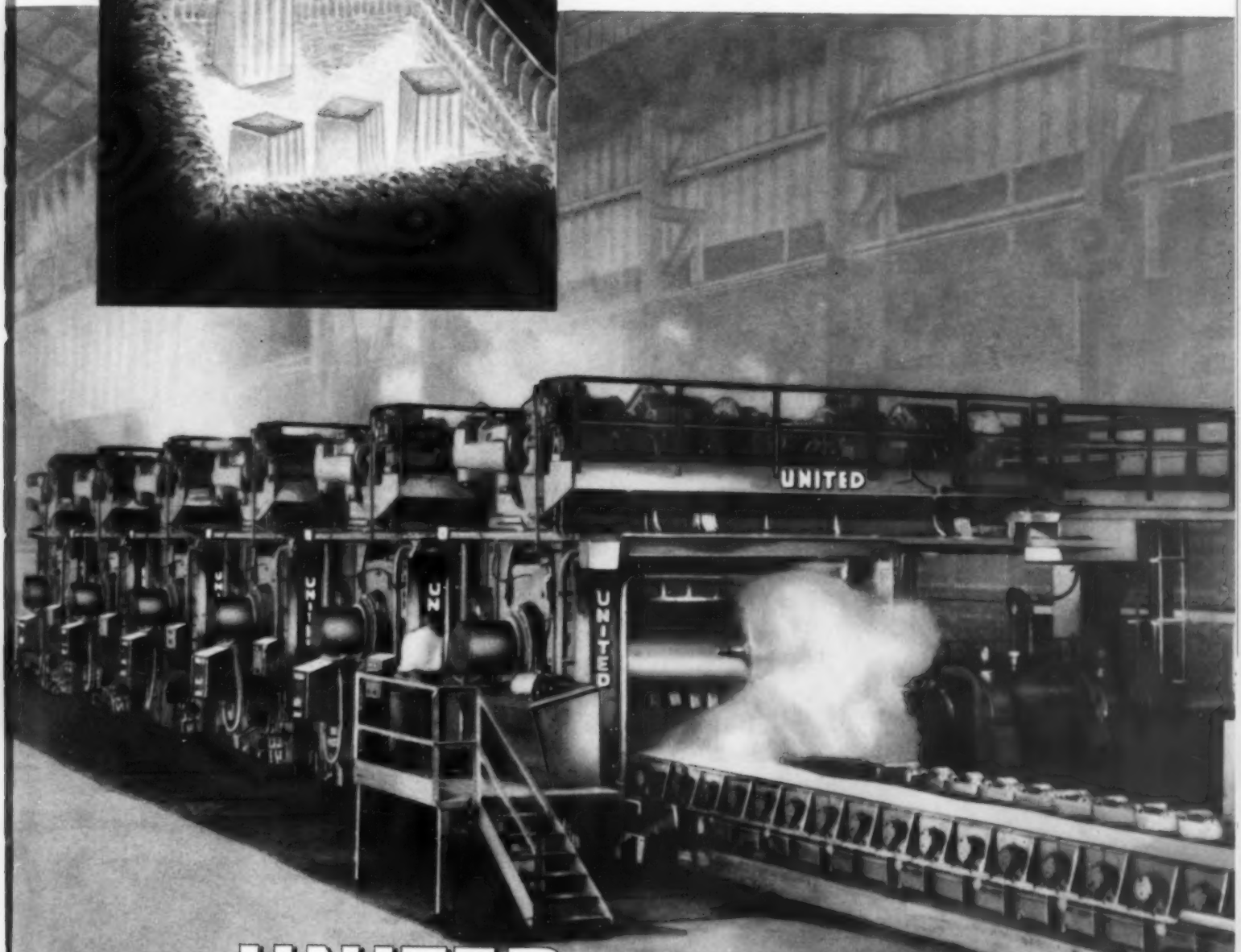

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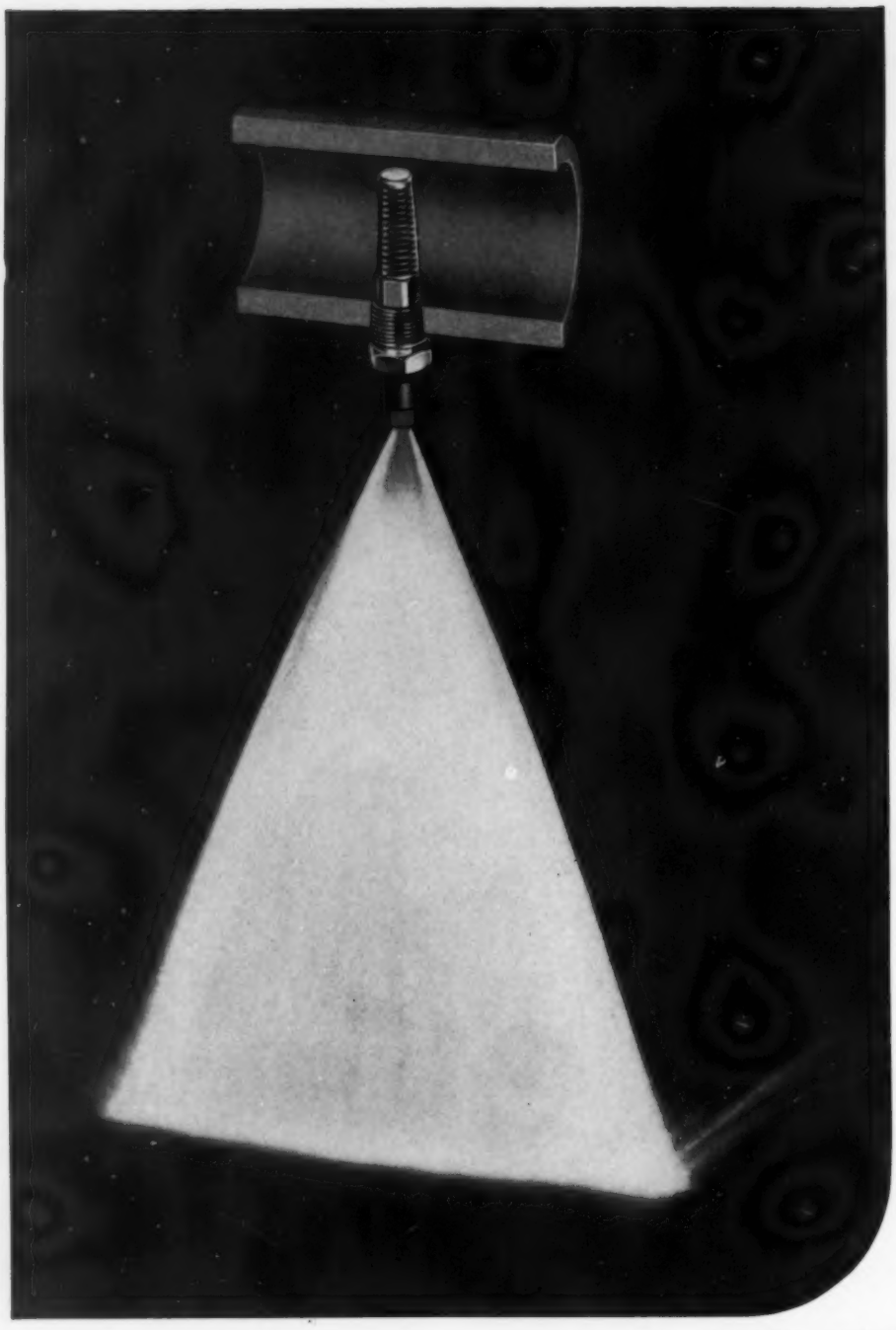

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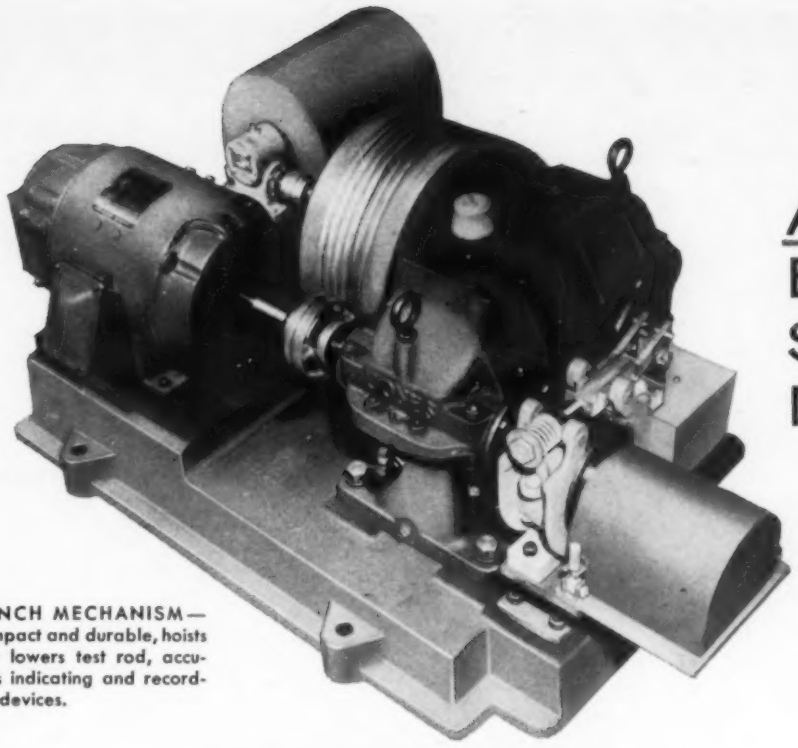

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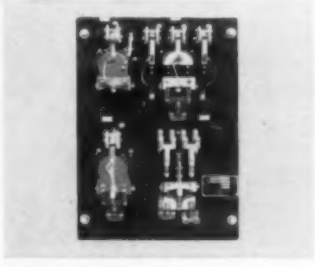
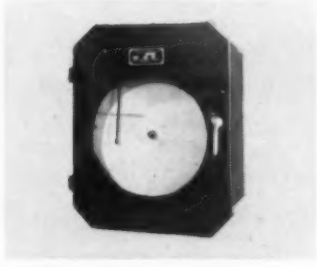
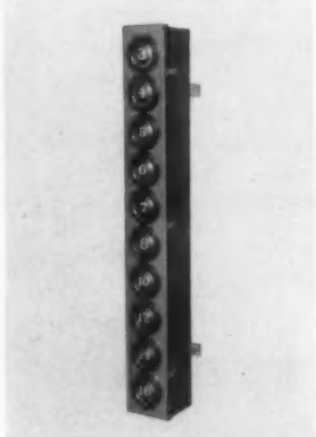
Freyn-Design STOCKLINE RECORDER



CONTROL PANEL—Motor and control resistors are installed in a wall mounted swing-out panel for easy access.



RECORDING METER—Selsyn operating recording meter records actual stock level on chart.



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Write for drawings and descriptive information, or consult our engineers.

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12 linings with 2 to 2-1/2 million tons . . . . total	28 millions
19 linings with 1-1/2 to 2 million tons . . . . total	32 millions
20 linings with 1 to 1-1/2 million tons . . . . total	24 millions
Total for linings with over 1 million tons . .	147 millions
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By MELVIN NORD, Patent Attorney, Detroit, Mich.

Patent Reviews

. . . . copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents . . . . patents reviewed cover period December 13, 1955 through January 3, 1956 . . . .

IMPACT APPARATUS FOR CLEANING METAL SCRAP

▲ U. S. 2,726,815, issued Dec. 13, 1955 to Eric H. Heckett and assigned to Heckett Engineering, Inc., describes an apparatus for continuous recovery of reusable metal scrap from the slag from steelmaking operations. The principal problem in connection with such scrap is the removal of encrustations of hard slag and hard masonry materials. In general, this is accomplished in the present patent by providing a tumbler barrel with rectangular side walls, so that during rotation of the barrel the material in it is subjected to a continuous impacting process.

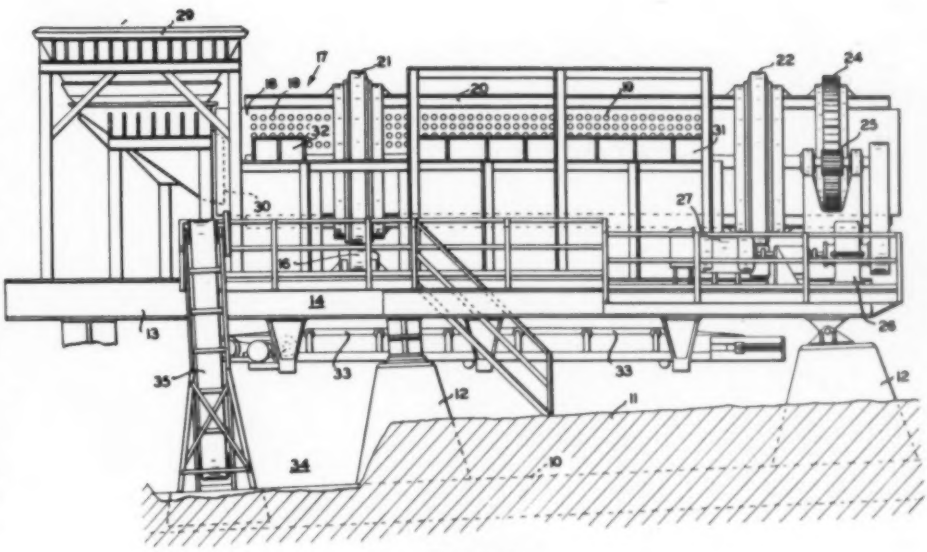
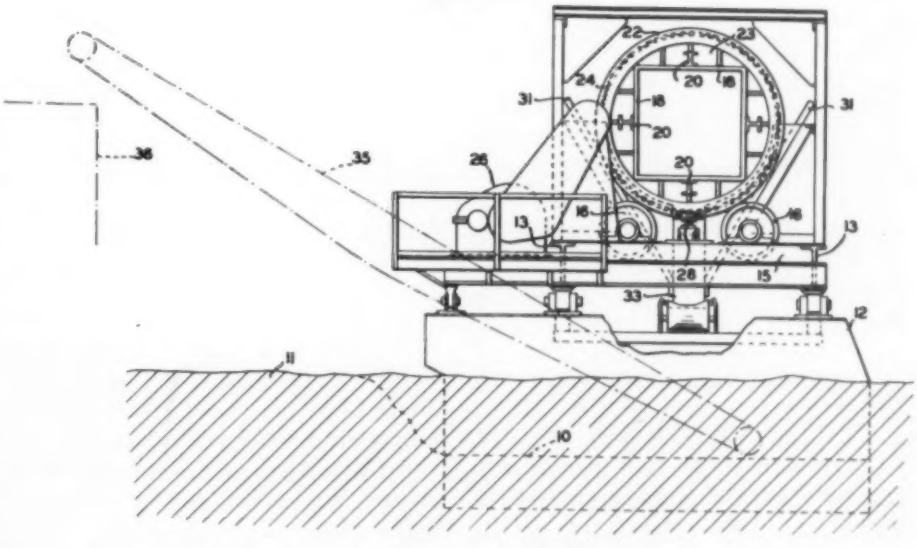


Figure 1

Figure 2



As shown in Figures 1 and 2, the apparatus is mounted on a heavy concrete foundation 10 which is firmly embedded in the soil 11 of the slag dump area. Supported on the foundation, on piers 12 is a framework of structural members including beams 13, which forms a supporting platform 14 for heavy-duty supporting rolls 16, which in turn support the rectangular tumbler barrel 17. The walls 18 of the tumbler barrel contain perforations 19 about 2 in. in diam, through which fall broken waste slag material and small particles of steel (generally called magnetic fines). The larger particles of free reusable steel are discharged from the open end of the barrel. In case any large pieces of slag are also discharged, fur-

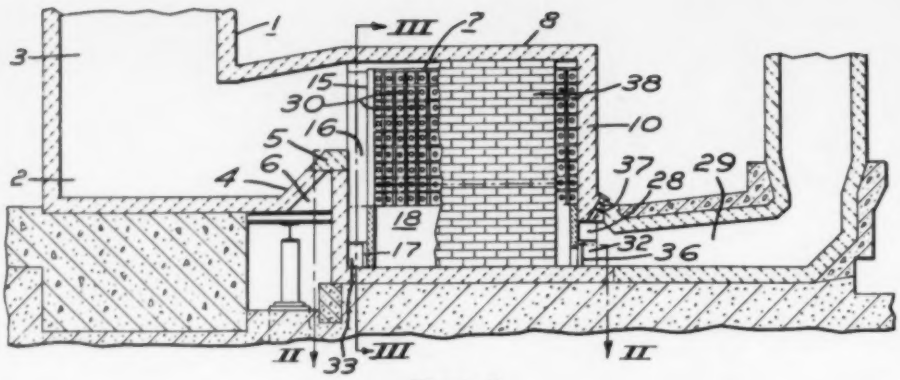


Figure 3

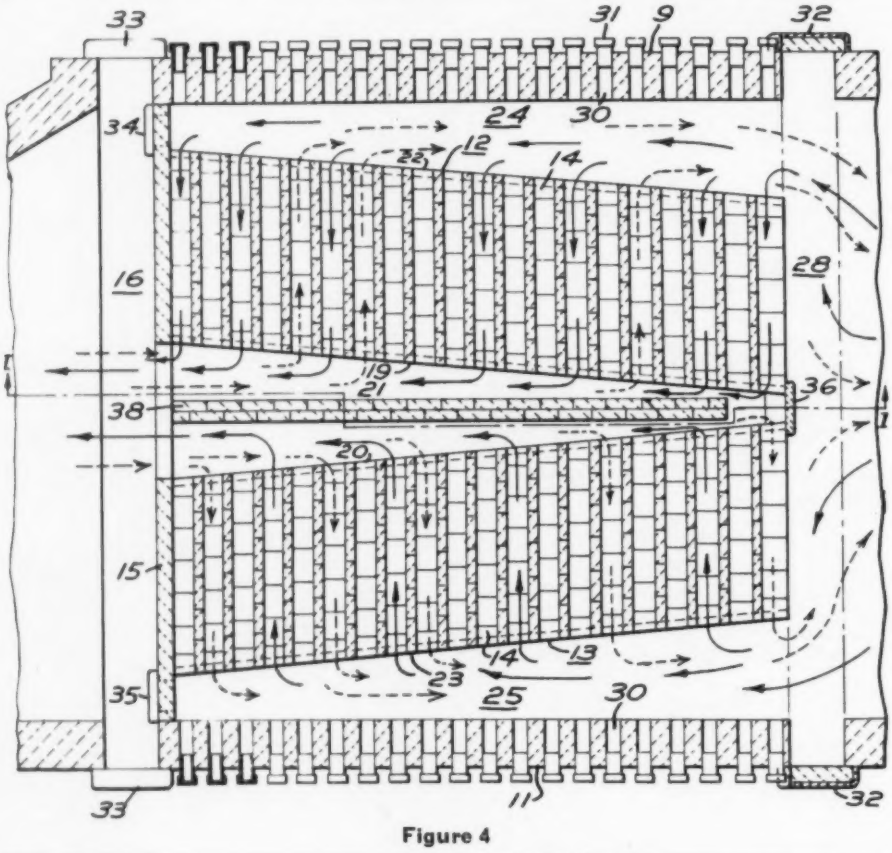


Figure 4

ther separation is then accomplished by use of a magnetic crane. The barrel is inclined downward at an angle of about 3 degrees, in order to aid the flow of materials by gravity.

The fines passing through the apertures 19 travel along the deflecting plates 31, onto a continuous conveyor belt 33, being deposited in a pit 34. A second conveyor 35 then conveys the fines to a gondola car 36 or to a suitable separating station, if preferred.

FURNACE REGENERATOR

U. S. 2,726,855, issued Dec. 13, 1955 to Ernest E. Lail, provides a furnace checker arrangement in which the checker passages can be readily cleaned and kept clean with a minimum of expense.

As shown in Figures 3 and 4, (the latter being a top view) the regenerator 7 is divided into two passes 12 and 13, side by side, each provided with horizontal ducts 14. A wall 15 extends across the front end of the passes, and they are spaced from the fantail arch and bridge wall 5 by a vertical passage 16 which terminates at the bottom in a soot pocket 17.

The hot exhaust gases (as indicated by the broken arrows) pass from uptake 3 through passage 21 and ducts 14 of each pass. (Incoming air follows the same path, but in a reverse direction, as shown by solid arrows, being heated by the duct wall surfaces.)

In order to facilitate cleaning of the ducts 14, walls 9 and 11 are provided with clean-out openings which are alined with the ducts 14. When it is desired to clean a duct, a cap 31 is removed and the duct may then be cleaned with a cleaning tool or with compressed air. Since the workers can see what they are doing, an efficient cleaning job can be done.

Compressed air can also be blown through the soot pockets 17 and 28 (and other soot pockets not shown here) by opening doors 32 or 33.

COMBINED FUEL AIR SUPPLY FEED FOR CUPOLAS

U. S. 2,726,856, issued Dec. 13, 1955 to Albert Maag, describes a combined fuel feeding and air supply device, with means for adjusting it vertically within the cupola and for removing it when desired.

The lower end of the device is protected from the high temperature of the melting zone by refractories and cooling water.

SELF-CENTERING STRIP ROLLS

U. S. 2,727,400, issued Dec. 20, 1955 to Edwin T. Lorig and assigned to United States Steel Corp., describes an arrangement for automatic centering of strip on rolls.

As shown in Figures 5 and 6, the pulleys 2 consist of a pair of opposed rotatable rolls 4 which are mounted on a stationary bent shaft 6. The axis of the shaft is bent so that the rolls will rotate about axes which are at a small angle to each other.

Each roll has a raised flange 30 at its outer end, and each roll increases

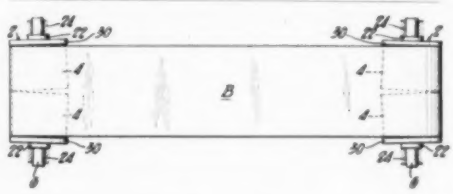
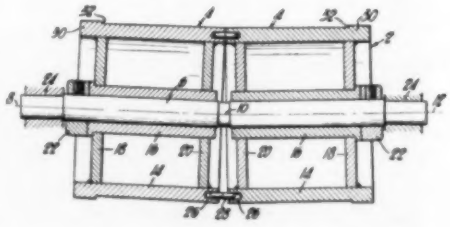


Figure 5

Figure 6



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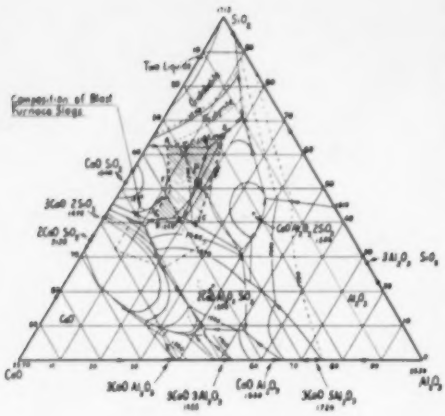


Figure 7

in diameter from the shoulder 32 to its inner end, the diameter of the inner end being greater than the diameter of the flange 30.

The end flanges and shoulders provide a funnel effect for the approaching belt B, as shown in Figure 5, thereby centering the belt.

CUPOLA FURNACE LINING

U. S. 2,727,737, issued Dec. 20, 1955 to William E. Dole, describes an improvement in the lining of cupolas.

It is customary to line the cylindrical metal shell of a cupola with blocks which have their entire outer edges in direct contact with the metal shell. With this arrangement, the blocks burn out quickly to an extent which causes hot spots to develop in the cupola shell. This occurs even when the blocks are three in. thick.

In the patent, the refractory blocks are so formed that when the cupola is lined with them there will be a space between the liner and the cupola shell. This serves as an insulating space, which prevents the formation of hot spots in the shell even when the blocks have worn down to one inch.

SMELTING OF IRON ORES

U. S. 2,727,815, issued Dec. 20, 1955 to Ingvald A. Kjellman, describes a method of smelting iron ore which results in low sulphur content, good manganese recovery, and high carbon content in the pig iron.

Finely divided iron ore and an acid slag consisting of CaO, Al_2O_3 and SiO_2 are mixed and briquetted. The primary acid slag formed in the sinter is easily fusible and highly reactive, and will absorb large amounts of iron oxide from the sinter. The iron content of the slag, however, is quickly reduced because of the close contact with the coke and reducing atmosphere, after which the acid slag can again react with additional iron oxide. Thus, the reduction process in the blast furnace starts at a very early stage, and is also concluded at an earlier stage. The final slag therefore has a low oxygen pressure. This permits increased retention of manganese and high carbon content of the pig iron. The low oxygen pressure of the final slag also tends to cause a high sulphur content in the slag, and hence a reduced sulphur content in the pig iron.

According to the inventor, the composition of the slag should be within the shaded area of the diagram, Figure 7.

APPARATUS FOR FEEDING RAW MOLTEN IRON AT A CONSTANT RATE

U. S. 2,728,123, issued Dec. 27, 1955 to James F. Jordan et al, describes an apparatus in which raw molten iron flows continuously into a continuous steelmaking process.

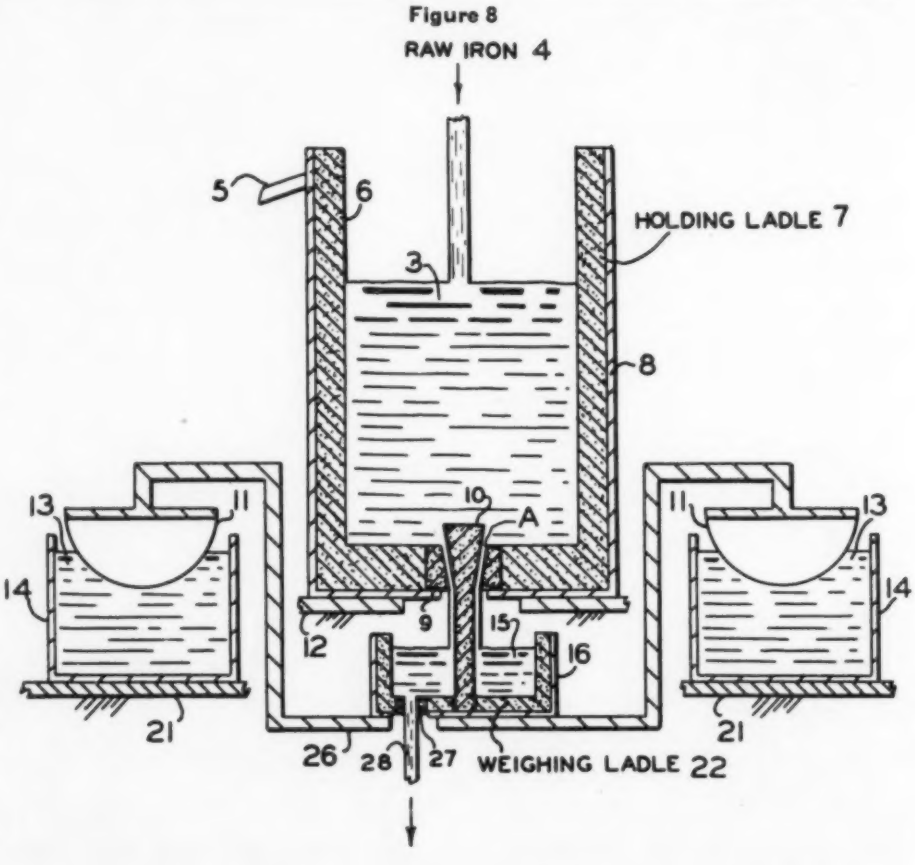
The apparatus is shown in Figure 8. The holding ladle 7 consists of a refractory lining 6 supported by shell 8. Raw iron is added to pool 3 within the ladle continuously or intermittently, and leaves through outlet A. Slag may overflow from spout 5. A tapered refractory needle 10 and body 9 constitute a valve in the outlet A. Molten iron discharges continuously into the weighing ladle 22, which is also lined with refractory.

The weighing ladle 22 is supported by floats 11 through connecting arms 26. The floats float on bodies of liquid 13 contained in vessels 14 which are rigidly supported. It is preferred to use three such floats (rather than the two shown).

Ladles 7 and 22 having been preheated, the level of pools 13 is lowered until needle 10 seats in the opening A of the holding ladle. Raw iron is then introduced into the ladle to a predetermined height. The level of pools 13 is then raised, thereby lifting the needle 10 and allowing the molten metal of pool 3 to flow into the weighing ladle and out through the opening 27 at the bottom. The level of pool 15 in the weighing ladle is adjusted in this way to a predetermined height.

The system is now under self-control. An increase in level in the hold-

Figure 8



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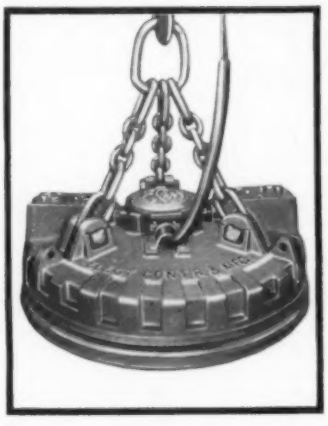
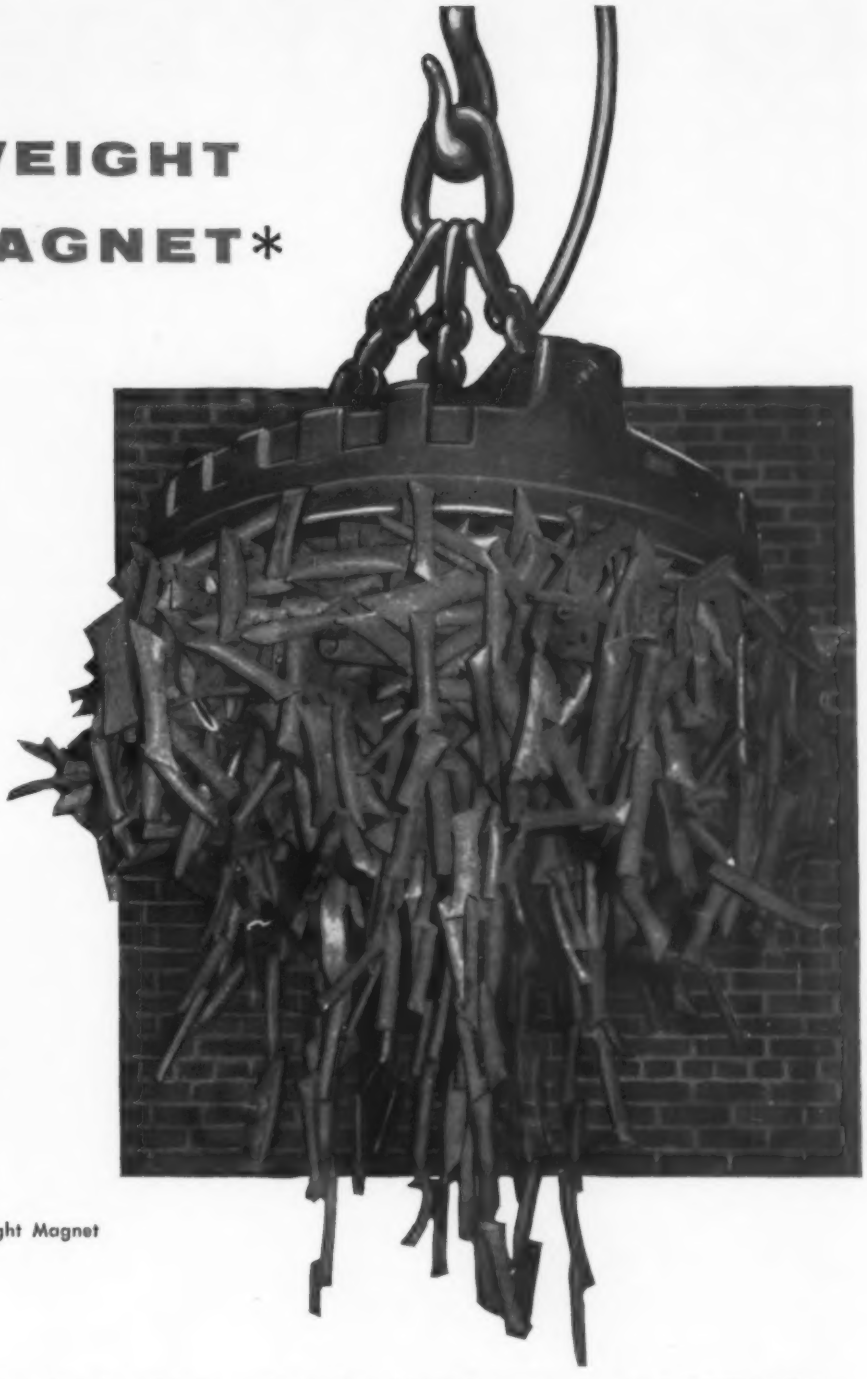


* Companion to the EC&M 45" Lightweight Magnet



This new magnet, developed by EC&M engineers, is the lightest weight 55-inch magnet. High strength and water-tight construction are maintained with a completely ALL-WELDED design. Elimination of bolt-head recesses allows a better proportion for coil space, giving high lifting capacity. Welding also keeps pole shoes tight.

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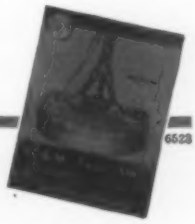
Write for Bulletin 900-L



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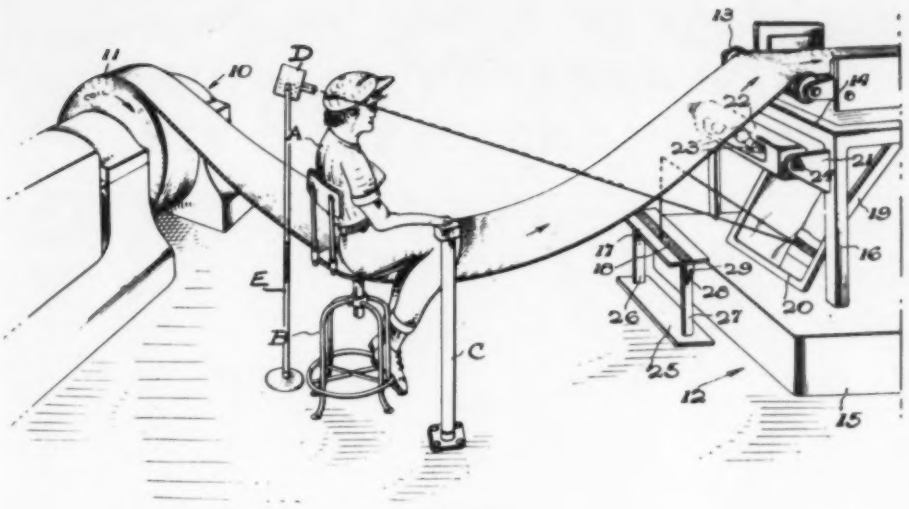


Figure 9

ing ladle tends to increase the flow of molten metal into the weighing ladle, because of the increased static head. This tends to increase the level of molten metal in the weighing ladle. This causes the weighing ladle to sink to a lower position, thereby tending to close the needle valve at the bottom of the holding ladle. A similar self-correction also occurs when the level in the holding ladle tends to decrease.

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or Assignee
2,726,458	12/13/55	Forced circulation horizontal cooling apparatus for continuous strip furnace	The Electric Furnace Co.
2,726,490	12/13/55	Billet grinder	Crucible Steel Co. of America
2,726,541	12/13/55	Measuring apparatus for rolling or drawing sheet or strip material	Raymond B. Sims
2,726,560	12/13/55	Method of perforating metal ingots	Pierre Roux
2,726,561	12/13/55	Apparatus for shaping tubular stock	Calumet & Hecla, Inc.
2,726,754	12/13/55	Rotary kickoff for cooling bed	The Aetna-Standard Engineering Co.
2,726,830	12/13/55	Blast fence for jet engines	Armco Steel Corp.
2,726,854	12/13/55	Shuffle-furnace bumper	American Gas Furnace Co.
2,726,952	12/13/55	Preparation of iron-aluminum alloys	Ford Motor Co.
2,726,971	12/13/55	Apparatus for drying and annealing wire	Syncro-Machine Co.
2,727,567	12/20/55	Scarfing torch	Air Reduction Co., Inc.
2,727,842	12/20/55	Process for the conversion of the surface of an iron article into magnetic	De Nederlands Centrale Organisatie voor Toegepast-Natuurwetenschappelijk Onderzoek
2,728,018	12/20/55	Regulation of electric furnace electrodes	Delaware Engineering Corp.
2,728,454	12/27/55	Portable apparatus for recovering steel scrap and metal-bearing fines from steelmaking furnace slag	Hackett Engineering, Inc.
2,728,533	12/27/55	Strip coiling apparatus	Jones & Laughlin Steel Corp.
2,728,544	12/27/55	Stacking boxes	Republic Steel Corp.
2,728,655	12/27/55	Method of producing iron powder with a low-silica content	Hoganas-Billesholms Aktiebolag
2,729,301	1/ 3/56	Cupola waste gas heat exchange and purifying system	Grindle Corp.
2,729,403	1/ 3/56	Winding drum for strip or wire	Plasti-Glo Mfg. Corp.
2,729,555	1/ 3/56	Method of operating blast furnaces with oxygen-enriched blast containing steam	Earl H. Shipley
2,729,556	1/ 3/56	Making pig iron or steel in a rotating cylindrical electric furnace	Mars G. Fontana

APPARATUS FOR INSPECTING TIN PLATE

U. S. 2,728,262, issued Dec. 27, 1955 to William J. Van Wye, and assigned to Republic Steel Corp., describes an apparatus for visual inspection of tin plate.

As shown in Figure 9, the tin plate 11 is continuously unwound from a reel 10, the coated surface facing downward and extending over an idler roller 13. Below the strip is a bright metal comparison plate 17 with an elongated center line 18 of contrasting color (e.g. black). The image of the comparison plate is reflected to a mirror 20 and then to the inspector's eyes. Light from a reflector 22 is also reflected from the bottom of the strip to the mirror and to the inspector's eyes. The two images appear side by side in the mirror, as shown in the diagram, making comparison very simple.

FLEXIBLE CONNECTION FOR RUNWAY GIRDERS

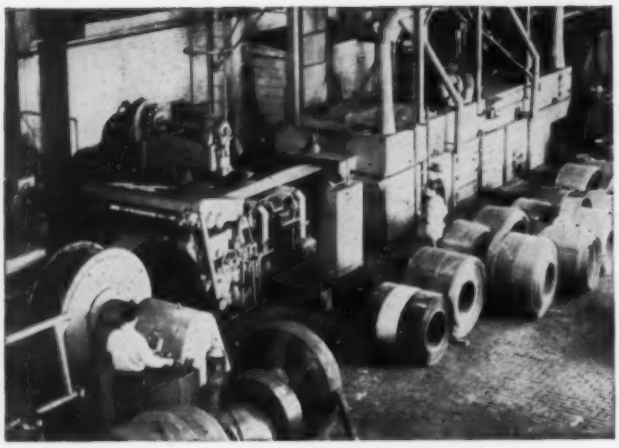
U. S. 2,728,424 issued Dec. 27, 1955 to James A. Evans relates to structural steel column and connected girder construction used in industrial or mill buildings, in which the girders are crane runway girders and have rails mounted on their top flanges.

The patent provides improved construction for column and connected girder construction by which direct thrusts only are transmitted from the girder top flange or top channel to the column, and by which all twisting forces set up in the girder top flange or top channel are resolved into direct thrusts and deflections indirectly transmitted to the column. The new construction minimizes deflections in the crane runway girders which might derail the crane bridge trucks.

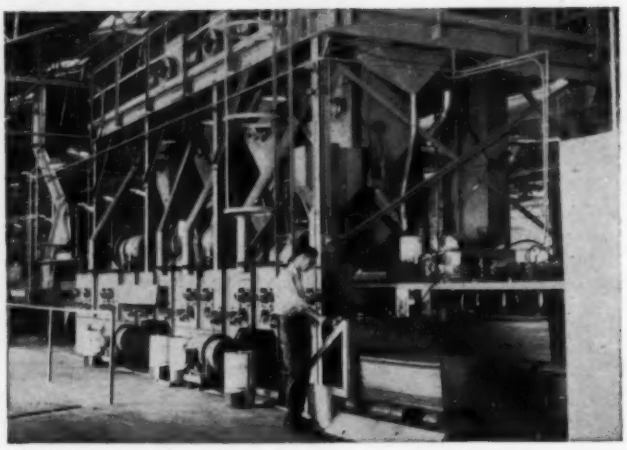
Are you annoyed by having someone borrowing your magazine when you want it? Get him to join the AISE.

In Steel Mill Processing

WHEELABRATOR® CLEANING SAVES MONEY EVERY TIME

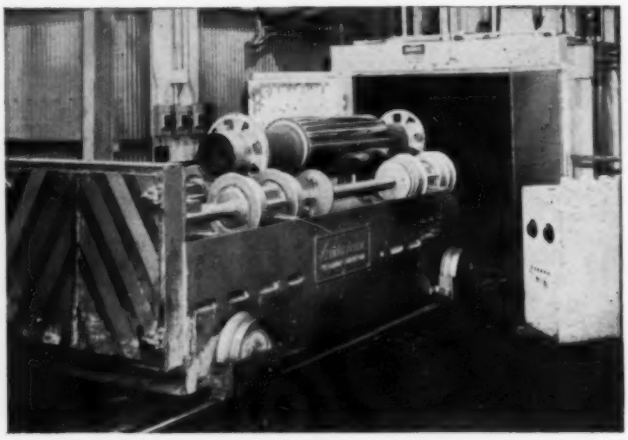


Descaling Strip at Allegheny Ludlum Steel Corp.



Descaling Sheet at Rheem Manufacturing Co.

Descaling Slabs, Billets at Atlas Steel, Ltd.



Etching Mill Rolls at U.S. Steel's Fairless Works

Mechanical descaling with the airless Wheelabrator as an integral unit in steel cleaning lines offers impressive savings in lower production costs for steel producers and fabricators alike.

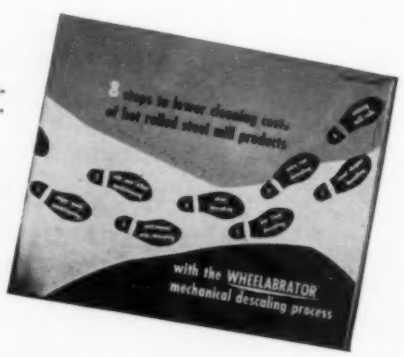
In descaling steel sheet or strip or etching mill rolls, Wheelabrator's controlled abrasive blast cuts costs in many ways: reduces or eliminates acid pickling; slashes labor costs, crane service and space requirements; improves product quality; adds to equipment life.

More than 60 Wheelabrator installations now descale slabs and billets, continuous carbon strip, sheet steel, bar stock, wire rod and structural steel shapes. They also condition ingot molds and etch mill rolls.

These achievements demonstrate Wheelabrator's leadership and ten years' experience in this field.

Write today for complete information on a Wheelabrator machine for your descaling requirements. Ask, too, for a test demonstration on your own products in our fully equipped laboratory or ask for the name of a plant where you can see the Wheelabrator in operation.

Write today for this fact-packed Bulletin, No. 864.



WHEELABRATOR
CORPORATION

WHEELABRATOR CORPORATION, 396 South Byrkit Street, Mishawaka, Indiana

FILE No. 156

the case of-- THE BEARINGS THAT SAVED THE PRODUCTION SCHEDULE

EARLY on a Sunday morning last December--a leading steel producer* was abruptly faced with production stoppage. One of the main bearings in its mammoth rolling mill had just burned out. And, no replacement was in stock. If repairs were not made immediately--the plant would be shut down Monday.

A hurried phone call to this company's bearing representative brought quick action. He promptly obtained the vital bearing and rushed it to the steel plant. But, shortly after he returned home, another urgent call came from the customer. The companion bearing on the shaft also had to be replaced. Again the bearing representative moved fast. On Monday, the mill was rolling at capacity--and the production schedule was maintained.

This is a typical case of the personal interest...and...extraordinary service this company gives customers in emergencies. In addition, regular orders are filled via speedy Boulevard Delivery...Bearing Surveys may be had for the asking...and...expert Bearing Engineering Service is available whenever needed. And, ALL for the price of the bearings. Why not phone an order--*NOW!*

SKF

One of the famous brands of bearings and specialties regularly carried in stock--for immediate delivery.

*Name on request

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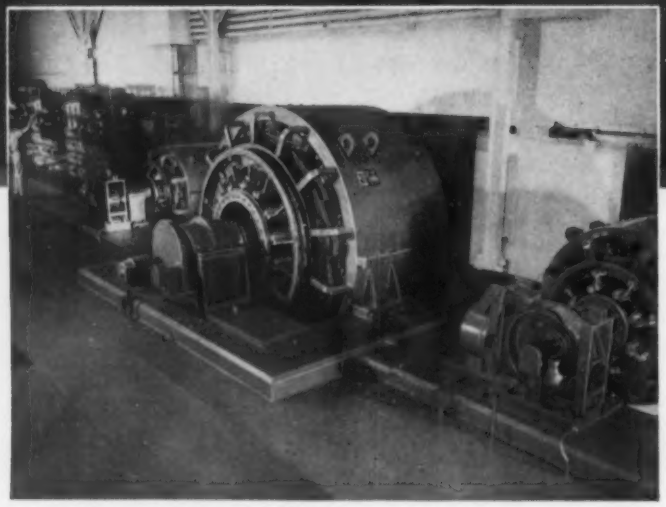
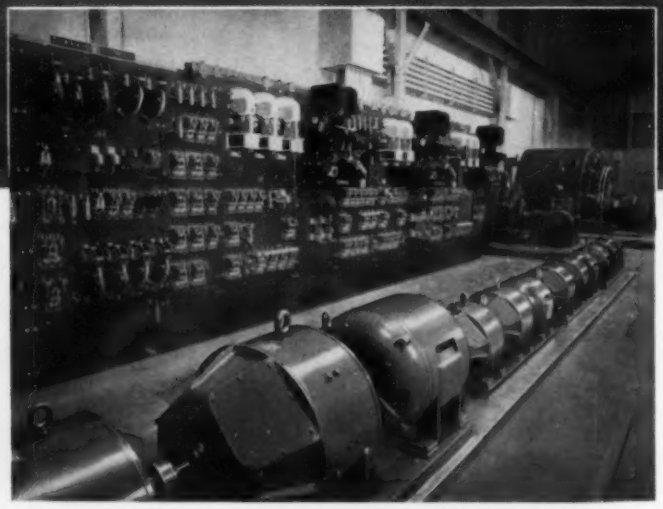
ELLIOTT

...setting the pace in cold mill

The Bliss 4-high, single-stand cold reduction reversing mill. Mill produces cold-rolled strip.



The Elliott 3000-hp, 150/375-rpm, 600-volt main mill drive motor (middle), is flanked by two special low inertia 1000-hp, 300/900-rpm, 600-volt motors with magnetic brakes which furnish power to the reels.



The d-c control board—the complex nerve center of all the d-c machines. Elliott C-W exciter sets are in the foreground. Elliott engineered the complete job, including switch-gear, controls and rotating equipment.

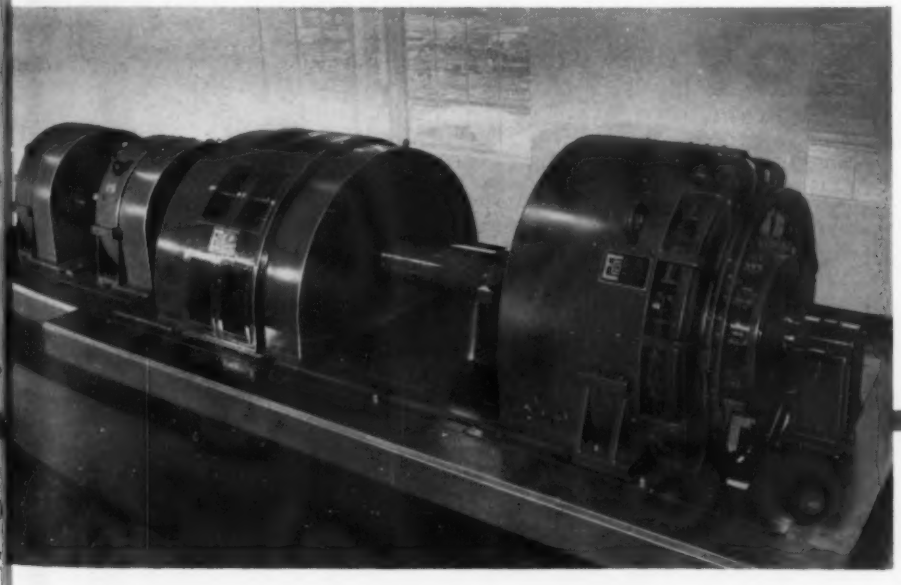
rotating electrical equipment!

NEWPORT STEEL CORPORATION'S NEW REVERSING COLD MILL

When Newport Steel dedicated its new four-high reversing cold mill in January, 1955, it marked not only the completion of one of the most modern and advanced mills of its kind but also a record-breaking construction and installation job. Erection of the mill began August 30th, and the *first test run of steel was rolled three months later!*

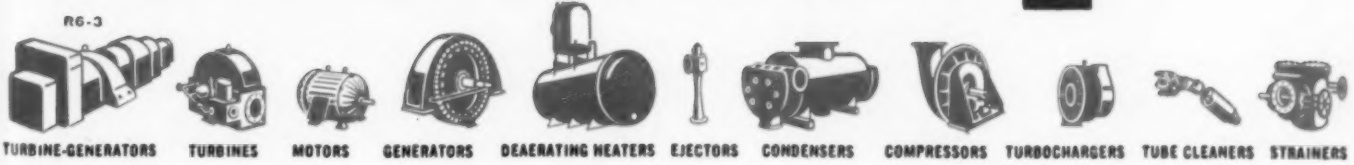
Part of the story behind this rapid completion can be found in the speed and efficiency of Elliott application engineering and manufacturing. *Elliott furnished and engineered all electrical apparatus, including controls, switchgear and ventilating equipment.* Pictured below are some of the large Elliott rotating electrical equipment, including the main m-g set, the 3000-hp main mill drive motor, the reel motors, and a number of auxiliary motors and other machines.

The application of Elliott equipment on jobs like this is coordinated by the Elliott Industry Engineering Department, which includes men with extensive experience in steel and related fields. For complete, up-to-the-minute information on Elliott steel mill equipment, write Elliott Company, Ridgway, Pennsylvania.



The Elliott motor-generator set. At left, the two 800-kw, 600-volt d-c generators (one for each reel drive motor). In the center, the 4500-hp, 13,200-volt, 514-rpm synchronous motor driver and, at right, the 2500-kw, 600-volt d-c generator which serves the main mill motor.

ELLIOTT Company



How to Keep Your Production in

GOOD SHAPE

Whether you are forming angles, rails or beams, bars or rounds, or any other shapes, National can supply the rolls that will stand up in your stands for longer tonnage life . . . rolls that are soundly cast and precision machined with accurately cut roll passes. To keep your production down time to a minimum, specify durable National rolls; they will more than meet your expectations.

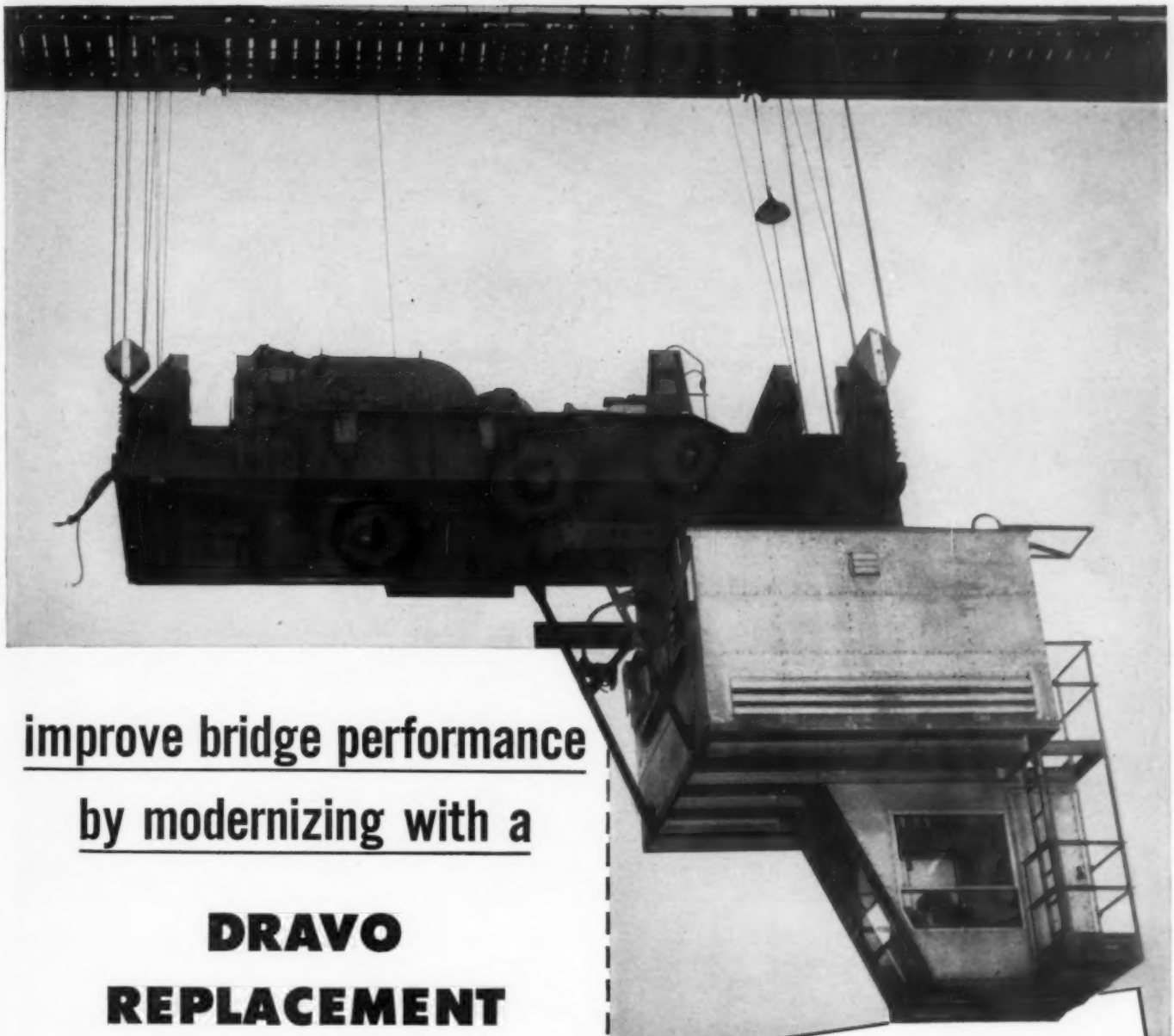
NATIONAL ROLLS

THE NATIONAL ROLL & FOUNDRY CO.

A Wholly-owned subsidiary of General Steel Castings Corporation

Avonmore, (Westmoreland County) Pennsylvania

Specialists in Iron, Alloy Iron and Steel Rolls. Carbon, Alloy and Manganese Steel Castings



improve bridge performance by modernizing with a

DRAVO REPLACEMENT MAN TROLLEY

Granite City Steel Company increased their ore bridge capacity, to meet higher production schedules, by installing a Dravo Replacement Man Trolley.

Each part of the trolley is designed to conserve weight and meet specific bridge loading conditions with complete safety. This design improves performance by permitting:

1. **the use of a larger bucket**
2. **a faster operating cycle**
3. **an increase in volume of material handled**

It takes less than 24 hours to install a Dravo Replacement Man Trolley. Write for complete information.

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BRIDGES AND UNLOADERS • TOWER-TYPE UNLOADERS
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MODERNIZED TROLLEYS FOR EXISTING BRIDGES
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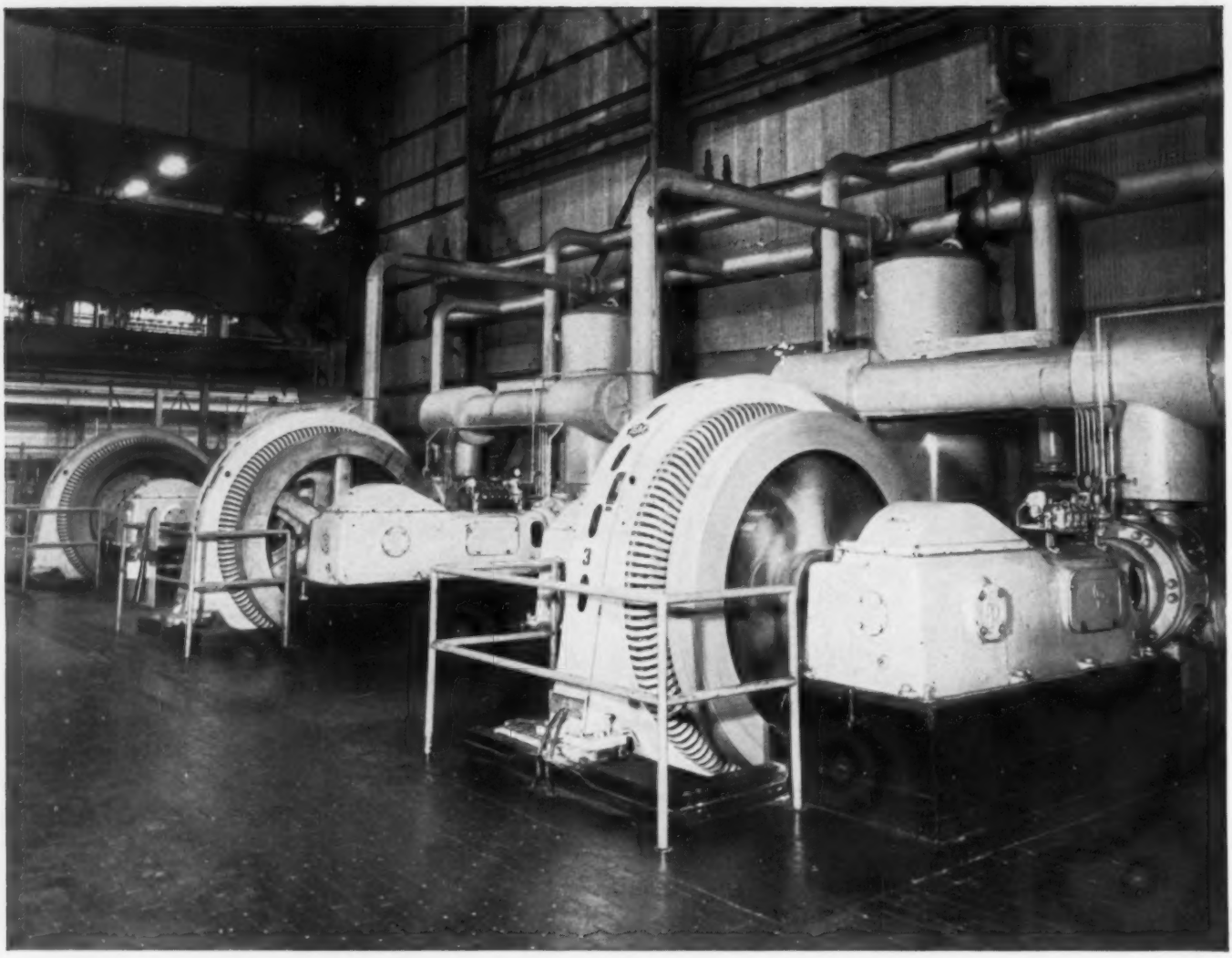

Above are three 500 hp, 225 rpm, 2300 volt, 0.8 power factor E-M Synchronous Motors driving air compressors in the tin finishing department at the new Fairless Works of United States Steel Corporation. Three other 500 hp and five 300 hp E-M Motors also drive air compressors, in the hot strip and slab mill, central power station, open hearth pumphouse and sulfate building of the coke works.

Power costs held low on compressor drives at new Fairless Works

Supplying air for controls, tools, handling systems and maintenance equipment is vital business at Fairless Works. And cost of power for operation of the air compressors is an item to be watched in such a large mill.

That's exactly where the E-M Synchronous Motors fit in. They help contribute real economy and rugged reliability to compressor operation.

First of all, these 11 E-M Motors are capable of supplying approximately 2700 reactive kva to improve plant power factor, a significant element when you want to minimize power costs.

Secondly, the inherent high efficiency of E-M Synchronous Motors utilizes power most sparingly.

Other economies are accomplished by use of simple and low-cost full-voltage control for across-the-line starting. Maintenance economy is foretold by simplicity of E-M Synchronous Motor direct-connection . . . by extra strong lashing of E-M stator coils . . . by the high capacity of E-M cage windings to withstand repeated starting stresses.

To get top performance from your large compressor drives, discuss your needs with your nearest E-M sales engineer. And write factory for E-M Synchronizer No. 32, a special issue on air compressor drive applications.

ELECTRIC MACHINERY MFG. COMPANY
MINNEAPOLIS 13, MINNESOTA

E-M

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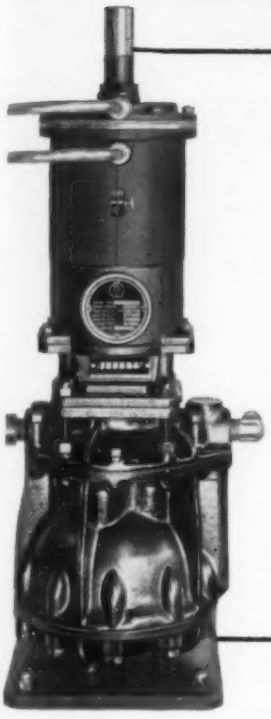
Specialists in making motors do
EXACTLY WHAT YOU WANT THEM TO

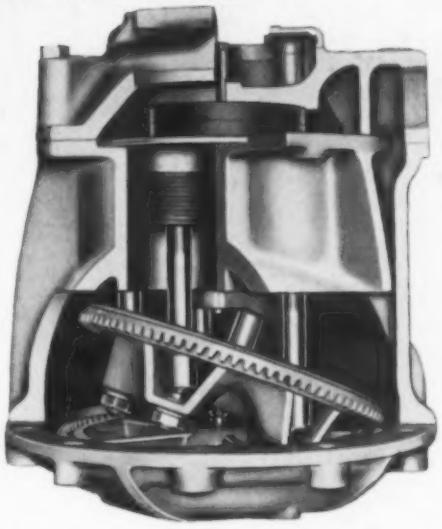
Why Positive Displacement Type Flow Meter Makes ASKANIA Transometers Best



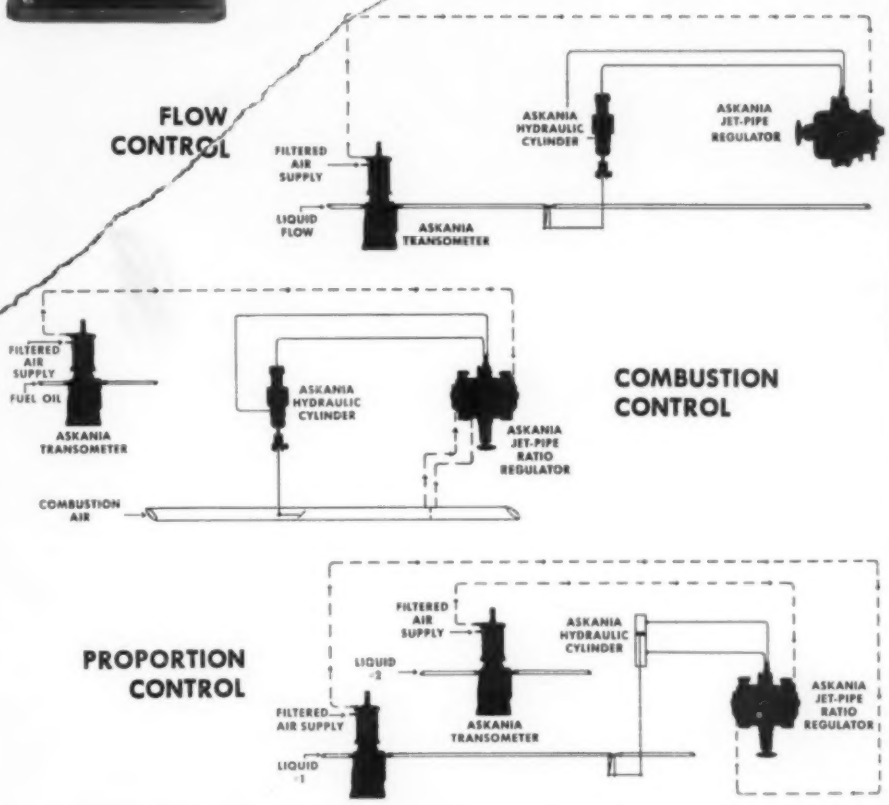
For Measuring, Controlling, Indicating, Integrating Flows of Fuel Oils, Viscous Fluids and other Liquids.

The Askania Transometer is a Positive Displacement *flow meter* that *also sends a pneumatic signal* for flow indication, recording and controlling functions.

Positive Displacement spells the difference between conventional flow meters and the Askania Transometer. Positive Displacement is the ONLY means for *accurate* measurement under ALL conditions of flow. Even changes in viscosity, pressure or temperature have no effect upon Transometer accuracy.



The Transometer measures flow by means of five cylinder cups and pistons such as the one shown here. These are successively filled with the fluid as the fluid forces the pistons downward. The fluid is measured by the "cup full" as the gear rotates at the base thus allowing one piston to be brought into motion in proper sequence after the preceding cup has been filled. *No fluid can pass through the system without being metered.* From small droplets to steady flow is measured with absolute accuracy. Note the all-carbon pistons which require no rings and the all-carbon wearing parts...which eliminate all metal to metal contact...which can be easily replaced without affecting the calibration of the metering unit. *Abrasive fluids create no problem!*



THREE FUNCTIONS

Askania Transometers are designed to: (1) Meter, (2) Integrate and (3) Provide Pneumatic Signal which is a square root function of the flow. This signal can be used to actuate an indicating meter and recorder—or it can be used to actuate an Askania Jet Pipe regulator for control purposes.

The diagrams show how the Transometer can be used to control (1) flow, (2) combustion and (3) blending or proportioning of two liquids.

ASKANIA Transometers are used for measuring a wide range of fuel oils, viscous fluids and other liquids such as: Abrasives, Extremely Viscous Asphalt and Coal Tar, gummy syrups and volatile ether and naphtha, etc.

For full information on how the Askania Transometer does all the jobs of the conventional flow meter...and with exact accuracy write for bulletin 301 to Askania Regulator Company, 246 East Ontario Street, Chicago 11, Ill.

ASKANIA REGULATOR COMPANY

"CONTROLS FOR INDUSTRY"

HYDRAULIC, ELECTRONIC CONTROLS & SERVOS, GENERAL SYSTEMS, ENGINEERING & COMPUTER SERVICE, VALVE ACTUATORS & CYLINDERS

A Subsidiary of General Precision Equipment Corporation

How U. S. Steel's **Robert Blacka** inspects the shaft for America's first full scale atomic power plant

You've read about our nation's first nuclear reactor power plant. It will be operated by Duquesne Light Company at Shippingport, Pa.—near Pittsburgh. Capacity will be a minimum of 60,000 kilowatts, using enriched and natural uranium as fuel, and light water as the moderator.

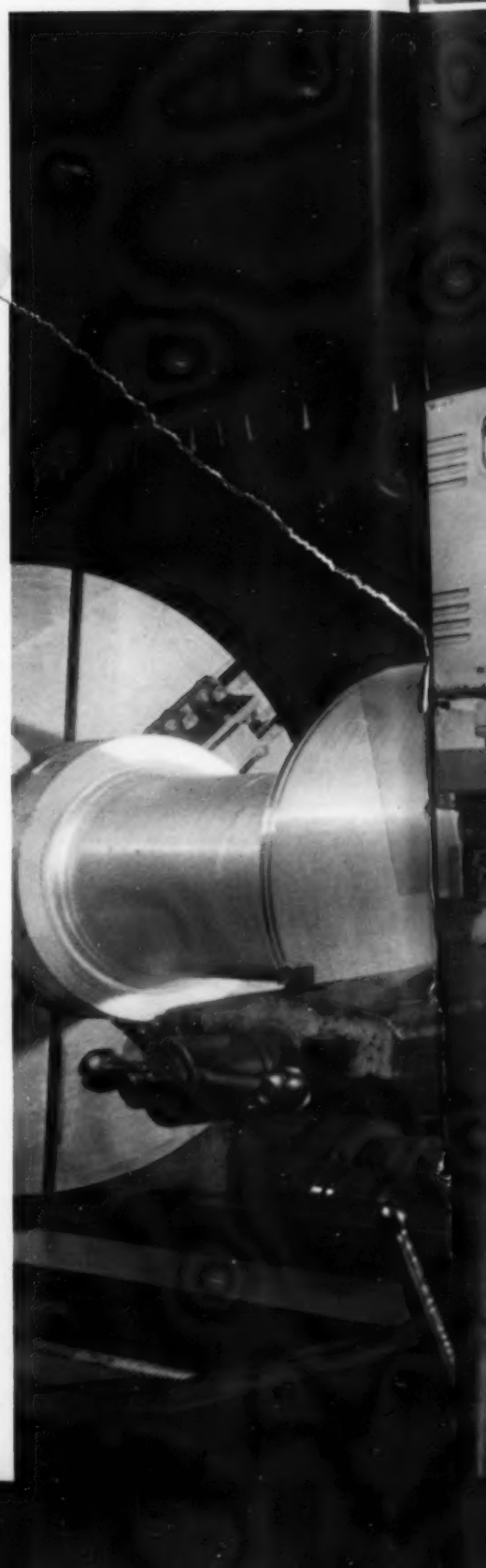
Westinghouse Electric is building the turbine generator. The first turbine shaft that will be installed is the one in the big picture, a USS Quality Forging being sonic-tested by Robert Blacka who has been a United States Steel Inspector for 16 years.

The instrument sends sound waves through the steel. The waves bounce back from the other side, and the entire journey is shown on the oscilloscope tube. Any imperfection in the steel sends a separate "echo" that can be analyzed by a skilled inspector.

Of course, there are other tests: macro-etching and microscopic examination, physical testing of bars to determine strength levels and ductility, magnetic particle and borescope inspection plus others—depending on customer needs.

USS Quality Forgings are very frequently specified when the buyer cannot tolerate the slightest compromise with quality. Part of the reason lies in United States Steel's complete array of test facilities—in the hands of seasoned inspectors who know how to use them.

Write for our free 32-page booklet on USS Quality Forgings. Address United States Steel, Room 5140, 525 William Penn Place, Pittsburgh 30, Pennsylvania.



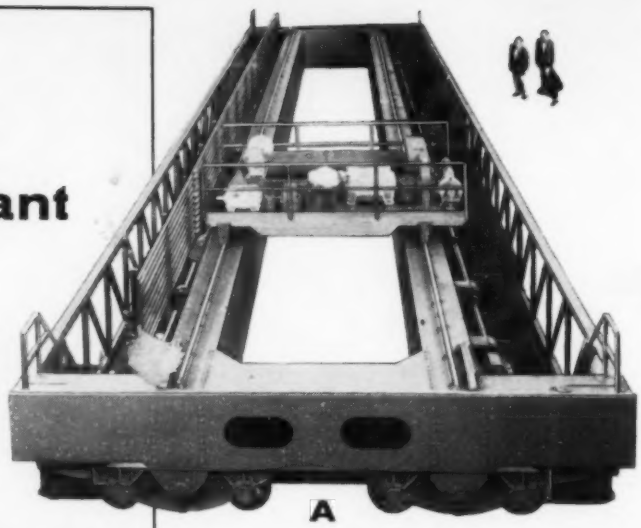
USS QUALITY FORGINGS

- heavy machinery parts . . . carbon, alloy, stainless
- forged steel rolls and back-up roll sleeves
- electrical and water wheel shafts
- specialty forgings of all types

UNITED STATES STEEL

SEE The United States Steel Hour. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

Get the Crane You Want
. . . turn to
SHAW-BOX



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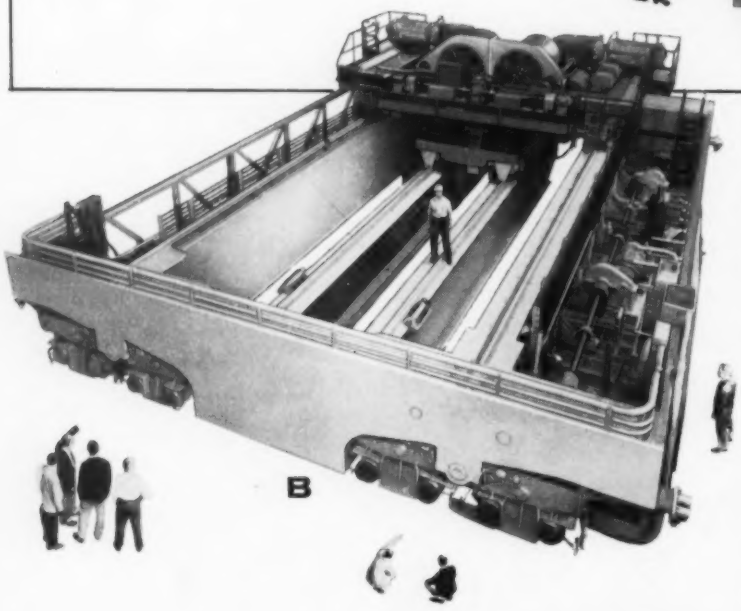

B

"Shaw-Box" Cranes are built exactly to specifications — your own or AISE Standard Specifications No. 6. Whether your plans call for a plate or slab handling crane, a soaking pit carriage, or a ladle crane, the long experience and vast facilities of Shaw-Box can save you time, trouble and money.

Make sure your next mill crane has the strength and rugged construction essential for 'round the clock service — plus economical operation. One of our engineers will gladly discuss specifications and tell you of our standard AISE designs for 15 to 200-ton cranes. Your inquiry is invited.

The pictures: **(A)** *25-ton, 100-foot span mill crane.* **(B)** *Ladle crane that handles 200 tons of molten steel in 90-ton ladle.* **(C)** *Plate handling gantry with lifting magnets. All have exclusive Shaw-Box structural, mechanical and operational advantages that assure reliable performance.*

C

"Shaw-Box"® CRANES

MAXWELL MANNING M&M & MOORE INC. TRADE MARK

MANNING, MAXWELL & MOORE, INC.

SHAW-BOX CRANE & HOIST DIVISION, MUSKEGON, MICHIGAN

Builders of "SHAW-BOX" and 'LOAD LIFTER' Cranes, 'BUDGIT' and 'LOAD LIFTER' Hoists and other lifting specialties. Makers of 'ASHCROFT' Gauges, 'HANCOCK' Valves, 'CONSOLIDATED' Safety and Relief Valves, 'AMERICAN' and 'AMERICAN-MICROSEN' Industrial Instruments, and Aircraft Products.

USG® BRUSHES
work in a steel mill...

for every Steel Mill job—the right brush* specification

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Mill Motors	USG Grade 135
DC Crane Motors	USG Grade 223
Diesel Main Generators	USG Grade AY 32 or 2306
Diesel Switcher Traction Motors	USG Grade 2207
Welding Generators and Exciters	USG Grade AH 897
Tin Line Collector Rolls	USG Grade 1658
Tin Line Generators	Grade on request
Cleaning Line Generators	Grade on request
DC Generators (DC Power Supply)	USG Grade 232
AC Crane Motor Slip Rings	USG Grade 550

*All USG brushes can be obtained with STATITE®, the permanent shunt connection, needing no hammerclips; cannot be jarred loose or pulled out.

Write for your copy of the complete USG Brush Catalog.

211

THE UNITED STATES GRAPHITE COMPANY
DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

Unique test furnace assures you of better end wall service

with Kaiser Periclase-Chrome Brick

THE refractory test furnace shown at the right was designed by Kaiser Chemicals to aid in the development of superior basic refractories for the steel industry.

One of the most important of its functions is to regularly test the effect of iron oxide and steel furnace slag on various bricks—including Kaiser Periclase-Chrome Brick.

As a result of such careful quality development and control, Kaiser Periclase-Chrome Brick are superior in your furnace—assuring less spalling, less swelling, greater resistance to abrasion and alteration by oxide and slag.

Leading steel producers have found that Kaiser Periclase-Chrome Brick can greatly increase end wall life or greatly reduce wall thickness, when this is preferred.

Let your Kaiser Chemicals sales engineer show you how you can get longer life from your end walls or reduced wall thicknesses with Kaiser Periclase-Chrome Brick. Call or write any of the sales offices listed below for immediate attention to your particular problem.

Kaiser Chemicals Division, *Kaiser Aluminum & Chemical Sales, Inc. Regional Sales Offices: 1924 Broadway,* OAKLAND *12, Calif. . . . 3 Gateway Center,* PITTSBURGH, *Pa. . . . 518 Calumet Building, 5231 Hohman Ave., Hammond, Indiana* (CHICAGO).

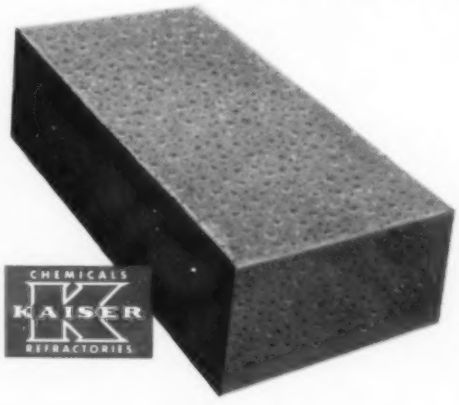
For the ultimate in steel furnace refractories

SOME OF THE REASONS YOU GET BETTER SERVICE WITH KAISER PERICLASE-CHROME BRICK:

1. Chromite content is the minimum amount (only 9.1% Cr_2O_3) necessary to provide thermal shock resistance. Lowering of chromite reduces swelling, thus minimizes end wall buckling.
2. A ceramic bond is formed *before* the chemical bond is destroyed.
3. No liquid phase in forming its ceramic bond. Volume stability.
4. Highest MgO content in end wall brick provides greater resistance to carryover erosion and iron oxide attack.
5. Lowest porosity minimizes alteration by resisting penetration of gases and impurities.

think of Kaiser Chemicals

Pioneers in Modern Basic Refractories



REFRACTORY BRICK • RAMMING MATERIALS • CASTABLES & MORTARS • MAGNESITE • PERICLASE • DEADBURNED DOLOMITE

Kaiser PERICLASE Brick for the Steel Industry:

- Kaiser Periclase Brick (D-S)
- Kaiser Periclase Chrome Brick
- Kaiser Chrome Periclase Brick

Now available! **A companion mortar for Kaiser D-S brick. High purity periclase composition *and* maximum workability.**

Installation advice on request

These slabs are still smoking. Yet, they're on their way to conditioning via Clark-Ross Carrier. There's no faster way to move material between mills.

Allegheny Ludlum "heat treats" their Clark-Ross* Carriers...moves loads while they're hot!

Here's a natural for the steel industry—the self-loading Clark-Ross Carrier. No tracks, no cranes—but instead, complete flexibility to move billets, sheets, or slabs where they're needed—and while they're still hot!

One man handles up to 50,000 lbs. and can work almost anywhere in the mill. Manual handling is just about eliminated—service between mills is highly speeded up.

But the Clark-Ross Carrier not only gives faster, more flexible handling . . . it saves money too. As one example, Allegheny Ludlum's Brackenridge works reports an estimated annual saving of $11,000.00 in handling slab alone.

One man operation, self-loading, self-unloading, truck speeds, complete flexibility, heavy capacities are just some of the Carrier's features. It's why we say the Clark-Ross Carrier is a "natural" for the steel industry. Give your local Clark dealer a call and ask for details. He's listed in the Yellow pages under "Trucks, Industrial."

These tracks used to be in use until the flexible Carrier came along. Now the job is done faster, cheaper and without special equipment.

*Clark-Ross is a Trademark of Clark Equipment Company

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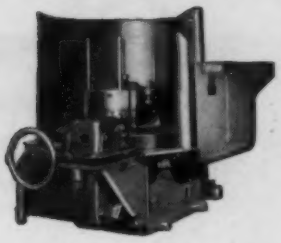

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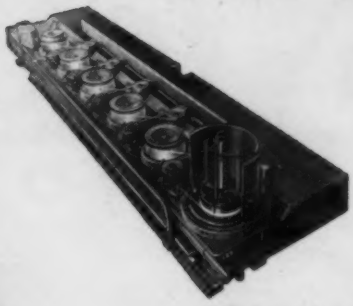

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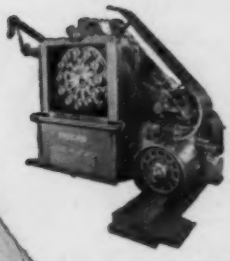

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For drawing the
largest tube or bar
to the finest wire—
ferrous or non-ferrous—
Vaughn builds the most
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ment you can install
for your operations.
Let us prove it.

"Quick on the Draw!"

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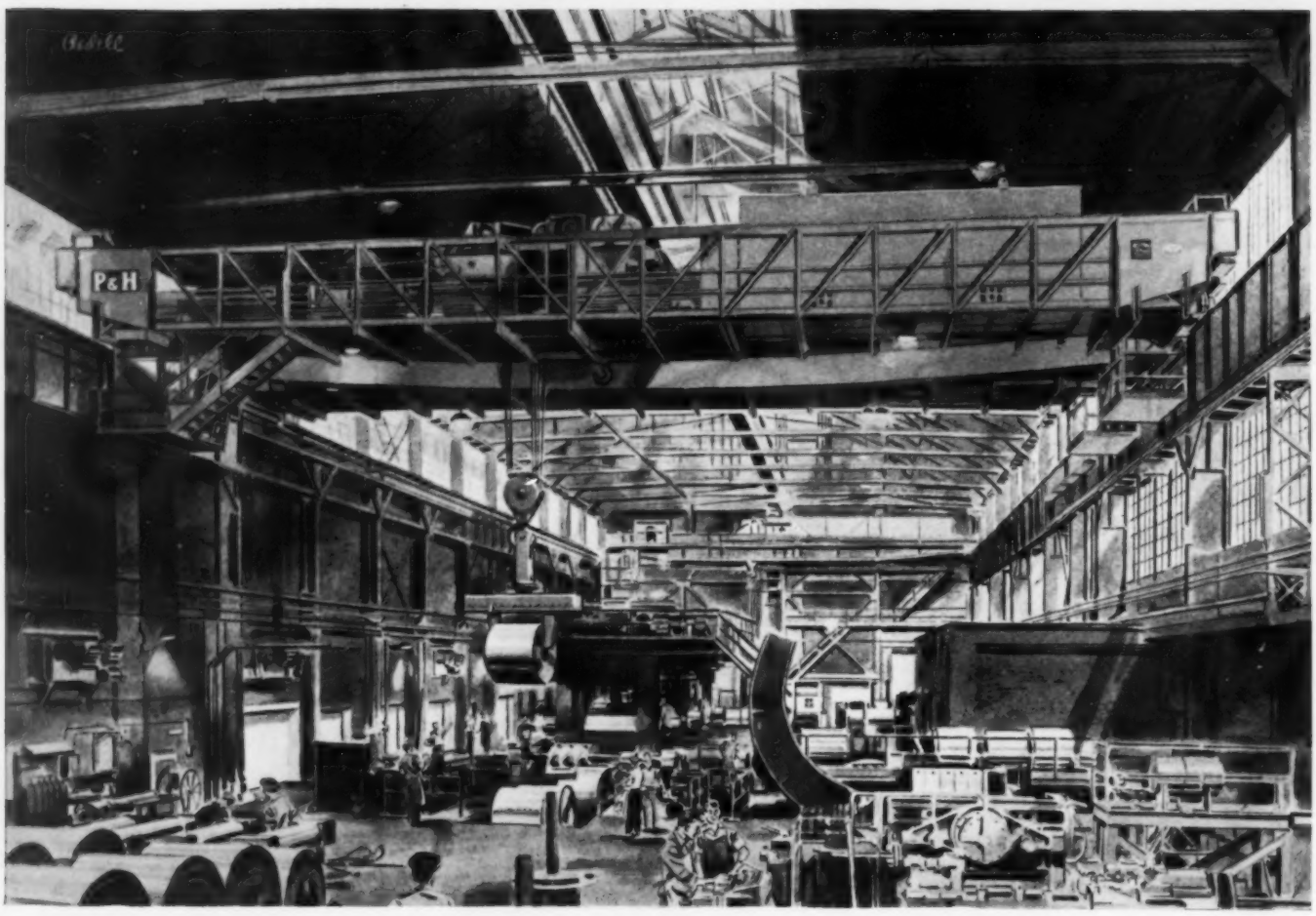

Satisfaction

. . . is a by-product of every P&H Overhead Crane

You get satisfaction from many things when you own a P&H Overhead Crane. First of all, you have the personal satisfaction of knowing that you've made a good, solid, substantial investment.

Then you have the satisfaction of quick, efficient service. You get it from one responsible source—there's no time lost in determining whom to call when you need quick action.

You have the satisfaction of smooth, effortless performance experienced by all P&H Overhead Crane users. And you get the added bonus of continued low maintenance costs.

But most of all, you get the kind of satisfaction from a P&H Overhead Crane that prompts you to buy another when you need it. This is a fact borne out by our experience. Twelve of our largest users employ a total of over 4,000 P&H Cranes in their various plants.

Remember to call in P&H engineers when you contemplate a new building with a crane installation. Meanwhile you may want to look over the free literature available. Just drop us a note on your letterhead.

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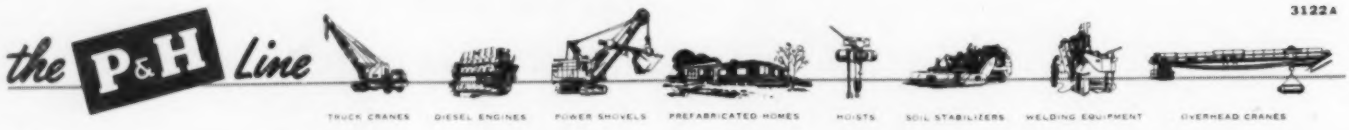
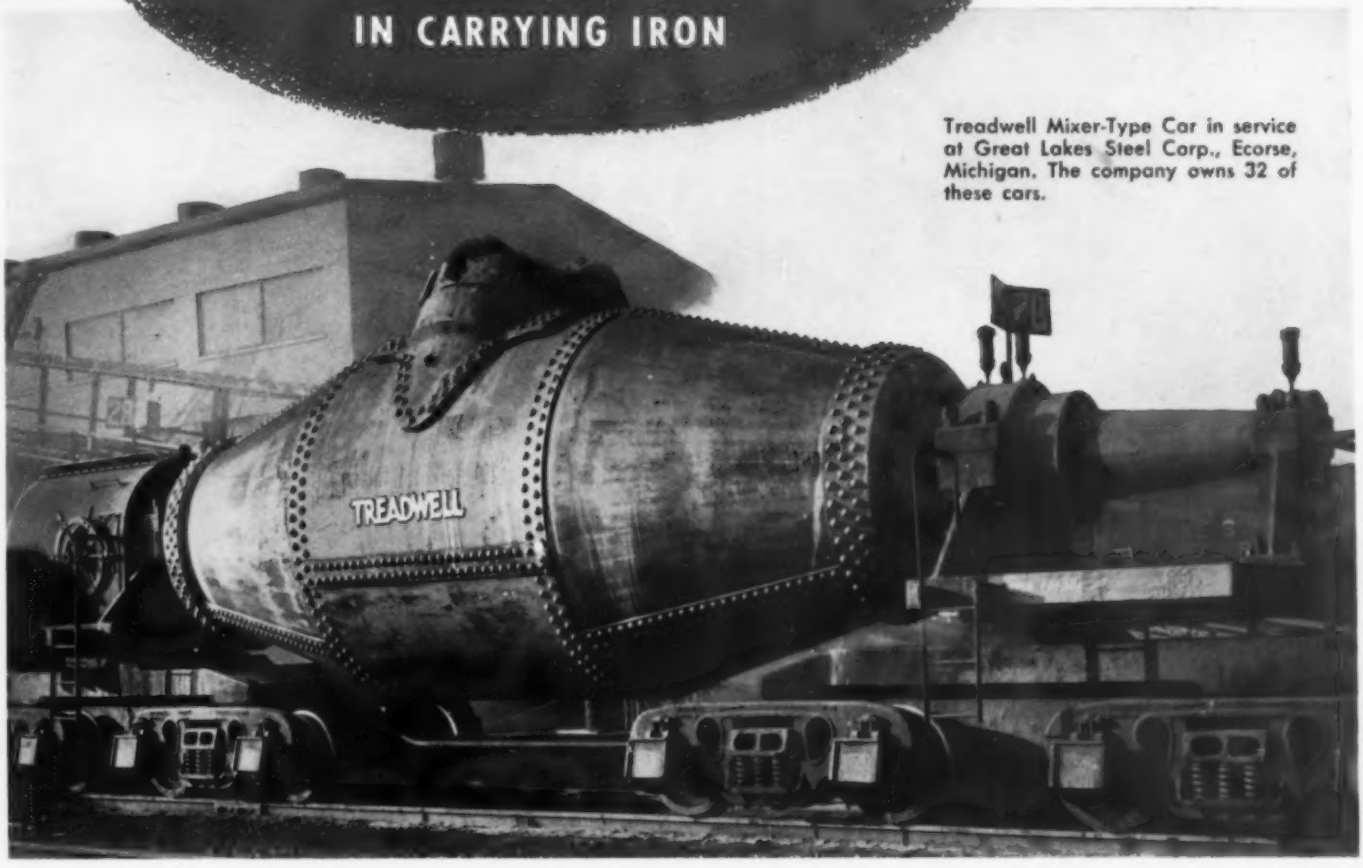


HOW GREAT LAKES STEEL *CUTS HEAT LOSSES* IN CARRYING IRON



Treadwell Mixer-Type Car in service at Great Lakes Steel Corp., Ecorse, Michigan. The company owns 32 of these cars.

Great Lakes Steel, Detroit division of National Steel Corporation, is able to cut heat losses by carrying iron in Treadwell Mixer-Type Hot Metal Cars, because these cars retain heat considerably better than open-top cars. This is true of both the iron carried and the lining of the ladle.

While heat loss in the mixer ladle of a Treadwell car may average 10° per hour, the loss in an open-top ladle may be as high as 55° per hour.

Hotter iron means less kish and, as a result, increased tonnage delivered to the steel furnace or pig casting machine. As it's common practice to hold cars at steel furnaces from three to six hours, and since many plants hold them ten to twelve hours, heat loss per hour is an important factor to consider.

Then too, shorter blast furnace runners can be used with mixer-type cars. This results in hotter iron at the ladle—50° hotter is reported by many plants.

But, greater heat retention is only one of the many advantages of Treadwell's exclusive Mixer-Type Hot Metal Car. Send for new bulletin No. 60. It describes these cars in detail.

M. H. TREADWELL COMPANY, INC.

140 Cedar Street, New York 6, N. Y.
1015 Farmers Bank Bldg., Pittsburgh 22, Pa.
208 So. LaSalle St., Chicago 4, Ill.

TREADWELL

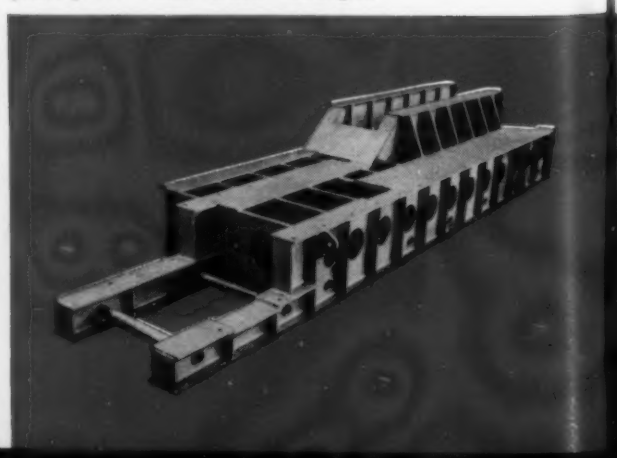
Mixer-type
HOT METAL CARS

TR-13

CONTINENTAL high-speed 21"x53"x60", 4-stand tandem cold mill in the Gibraltar Plant of the McLouth Steel Corporation.

CASTINGS—carbon and alloy steel castings from 20 to 250,000 pounds.

WELDMENTS—fabricated steel plate, or cast-weld design.



BLAW-KNOX
makes what it takes
to cold roll
at high speeds

In the Gibraltar Plant of McLouth Steel, this modern CONTINENTAL 60-inch, 4-stand tandem cold mill rolls steel at delivery speeds in excess of 3,000 fpm.

Designed to meet specific customer requirements, the mill has interesting features, such as—(1) entry and delivery coil conveyors of this cold strip mill, and two single-stand skin-pass mills, are at floor level—which provides greater safety, more efficient handling and easy inspection of all coils during processing. (2) mill equipment has built-in raceways to carry the electrical cables—which simplified the installation and provides easy access for maintenance.

BLAW-KNOX designs and builds *complete* rolling mill installations—assumes undivided responsibility from preliminary engineering to satisfactory operation. At any time we'll be glad to discuss your plans with you.

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Foundry and Mill Machinery Division
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Complete Rolling Mill Installations . . . Including all auxiliary equipment . . . for ferrous and non-ferrous metals

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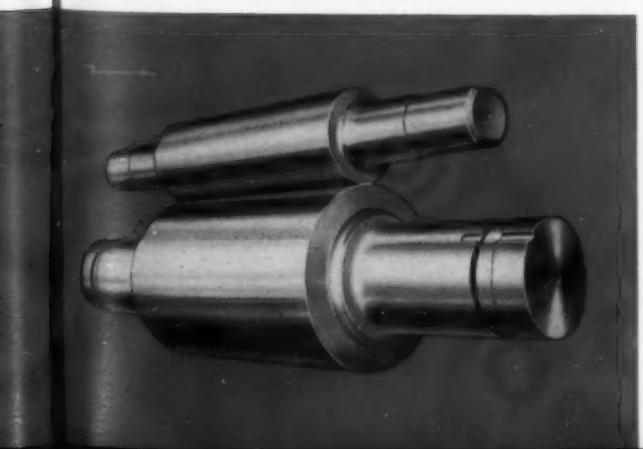
ROLLS—Iron, alloy iron and steel rolls for all types of rolling mills.



50th Anniversary
BLAW-KNOX
1906-1956

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2-7½ TON HOOKS
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MODERN ALL-WELDED STEEL MILL CRANES
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Crops and Shorts

ANNUAL reports of the steel industry for 1955 generally showed record output and record profits. Since the turn of the year, production has continued at a record rate, with the first quarter of 1956 showing similar records.

March, which shares with October the distinction of being a "record" month in the steel industry, lived up to its reputation as the industry set new monthly records at 10,924,788 tons of steel ingots and 7,083,877 tons of pig iron. These records helped to establish new quarterly records of 31,872,014 tons of ingots and 20,609,021 tons of iron for the first three months of 1956.

Subsequently, the week of April 8th saw a new weekly record of 2,483,000 tons of ingots.

▲

STEELMAKERS differ somewhat as to the outlook for the remainder of 1956. Some do not believe their customers have built up inventories. Others think their customers are heavily inventoried. Many look for a drop in business subsequent to a price increase that must follow the inevitable wage raises of midyear.

▲

THE AISE spring conference just over in Baltimore was one of the most successful ever held. Registration totaled more than 990, surpassing all spring meetings except that in Philadelphia in 1954. Approximately 450 made the trip to Sparrows Point, where Bethlehem Steel Co. staged a well-planned inspection visit. The technical sessions were interesting and well attended, and the Lord Baltimore Hotel took care of all meeting functions in fine style. From what we hear, some extra-curricular activities took place in the Oasis, Piccadilly and similar spots.

▲

A nice thing about spring is that you get away with letting natural laziness take over by calling it spring fever.

▲

ACCORDING to the American Iron and Steel Institute, domestic iron ore shipments in 1955 were about 120,000,000 net tons. In addition, 26,300,000 tons of ore were imported: 11,300,000 tons from Canada, 8,000,000 tons from Venezuela, and between one and two million tons each from Liberia, Peru, Sweden and Chile.

▲

DURING the record year of 1955, the steel industry had a payroll of $3,597,556,000. Employment totaled 657,000. Wage earners averaged 39.2 hours per week at an average rate of $2.509 per hour. In addition, pensions, social security and insurance cost 21.3 cents an hour.

▲

MOST of our readers will think their respective wives wrote this gem from the Wall Street Journal:

In cleaning out our attic
I find two separate pleasures —
Disposing of my husband's trash,
Straightening out my old treasures.

▲

IN 1955, traffic accidents killed 37,800 people and injured 2,158,000. More than 41 per cent of the deaths and 35 per cent of the injuries occurred on Saturdays and Sundays. Three out of four traffic accidents happened in clear weather on dry roads and 85 per cent of the vehicles involved were passenger cars. Of all drivers involved in fatal auto accidents, 27 per cent were under 25 years of age.

▲

SURVEYS in areas of Canada show that 90 per cent of all automobile accidents in an area were caused by 10 to 15 per cent of all drivers — and 90 per cent of these accidents happened to cars in good condition on dry, well-built roads.

▲

THE National Association of Manufacturers believes that Congress should investigate how and to what extent "monopolistic practices by labor unions should be regulated and controlled in the public interest."

The NAM cites court cases to show that a double standard exists in the application of the federal antitrust laws — one under which business monopoly is prohibited and the other under which union monopolistic practices are freed of restraint.

The association says that any industrial merger bringing together anything approaching the concentration of economic and political power as that involved in the merger of the AFL and CIO would almost certainly come under close scrutiny.

▲

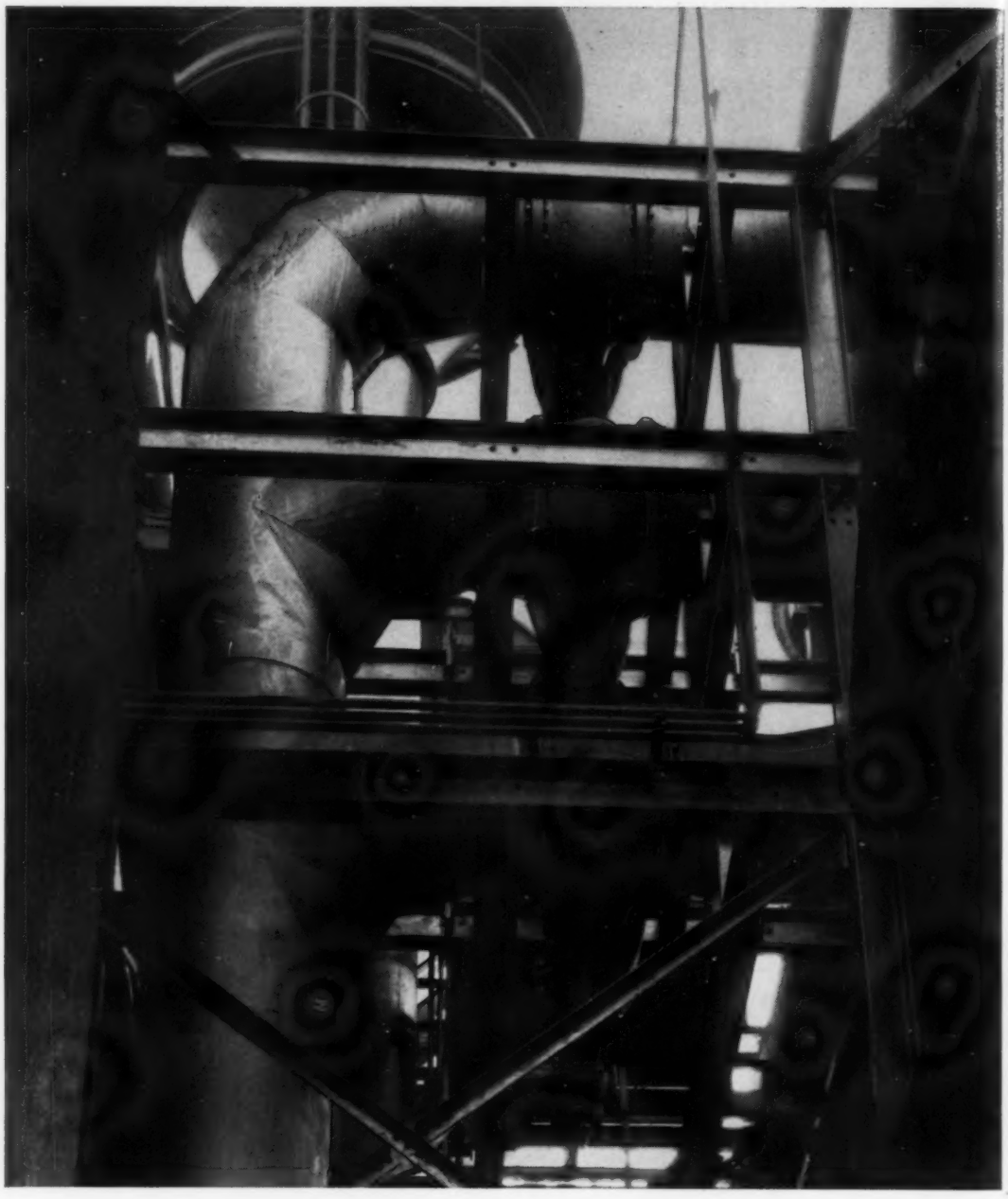
KREOLITE NEWS reports this letter to a credit bureau: "Sorry this bill has remained unpaid for so long. I've been married and have been on my honeymoon. As soon as I get on my feet I'll be in to make a payment."

▲

IN a recent survey of Carnegie Institute of Technology alumni, only 2391 listed their occupation as engineer, although approximately 11,500 of the alumni hold degrees in engineering or science. A majority of science and engineering alumni, are functioning in the higher echelons of administration and management.

Of the total alumni surveyed (about 18,000), the largest group (3245) gave their occupation as housewife. Next came the 2391 engineers.

In all, 1240 distinct occupations were listed. An interesting return was that of Charles E. Wilson, U. S. Secretary of Defense, who listed his occupation as "secretary."



View of blast mains showing the 3-way split.

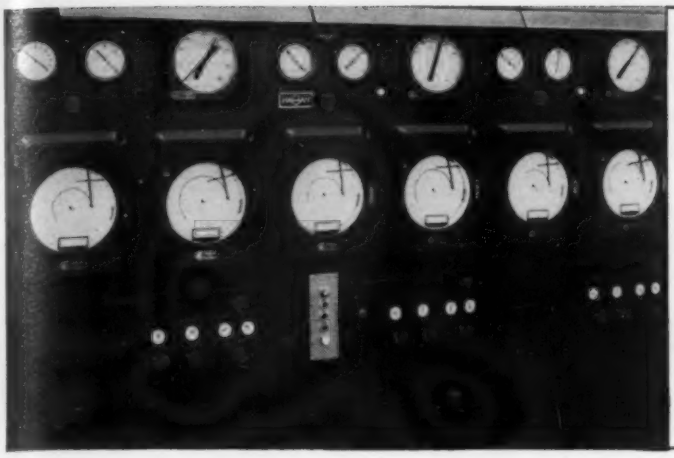
HAGAN perfects split

Installed at Duquesne Works of U. S. Steel

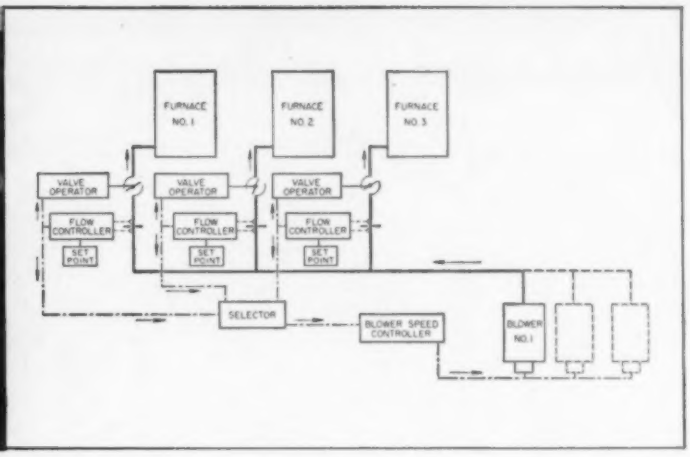
Now in successful operation on blast furnaces at the Duquesne Works of U. S. Steel, the Hagan control system assures high efficiency and operating economy by means of a new approach to the problem of split wind blowing.

1. Instead of throttling all cold blast control valves, the Hagan System automatically selects the furnace requiring the highest blast pressure and holds the control valve for this furnace wide open, at the same time controlling flow to this furnace by varying blower speed. Throttling takes place only on the other furnace flow control valves. Blower discharge pressure is held to a minimum.
2. The Hagan system maintains true air flow in scfm (30″ Hg. and 60°F) by means of *automatic* pressure and temperature compensation. Metering with Hagan Ring Balance Recorders is on the same basis.

The Hagan split wind blowing control system is completely automatic. Once furnace air flow is set by the operator, the system automatically maintains the set air flow, adjusting to varying



Front of control panel for split wind blowing control of 3 furnaces.



Simplified block diagram of Hagan split wind blowing control system.

•

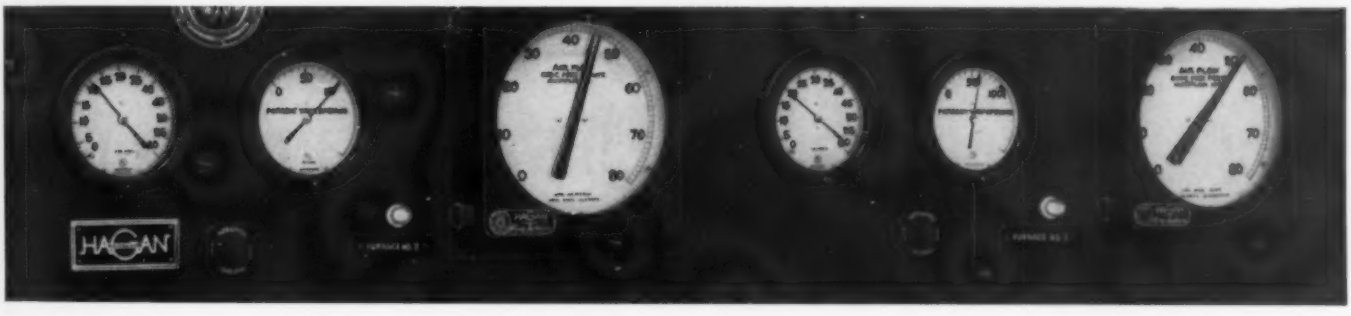
Detail of panel showing conditions of Furnaces 2 and 3 which are on split wind blowing. The first two dials for each furnace show blast pressure and valve opening; the dual indicator shows air flow set point and actual air flow.

Note that the control valve for No. 2 Furnace is held wide open and that the flow to No. 2 is being controlled by blower speed.

•

Under this condition, the total permanent pressure loss across the metering orifice and control valve is about 3" w. c. at full blast.

Whenever Furnace No. 3 requires the higher blast pressure, the condition shown here will reverse. The control valve for No. 3 Furnace will open wide, with No. 2 throttled. Selection of the control valve requiring the highest blast pressure is automatic.



t wind blowing control

conditions of air temperature, air pressure and furnace burden. The Hagan system may be used with any combination of furnaces and blowers in multiple. Accurate and reliable, Hagan controls make good housekeeping easy by using pneumatic transmission and control.

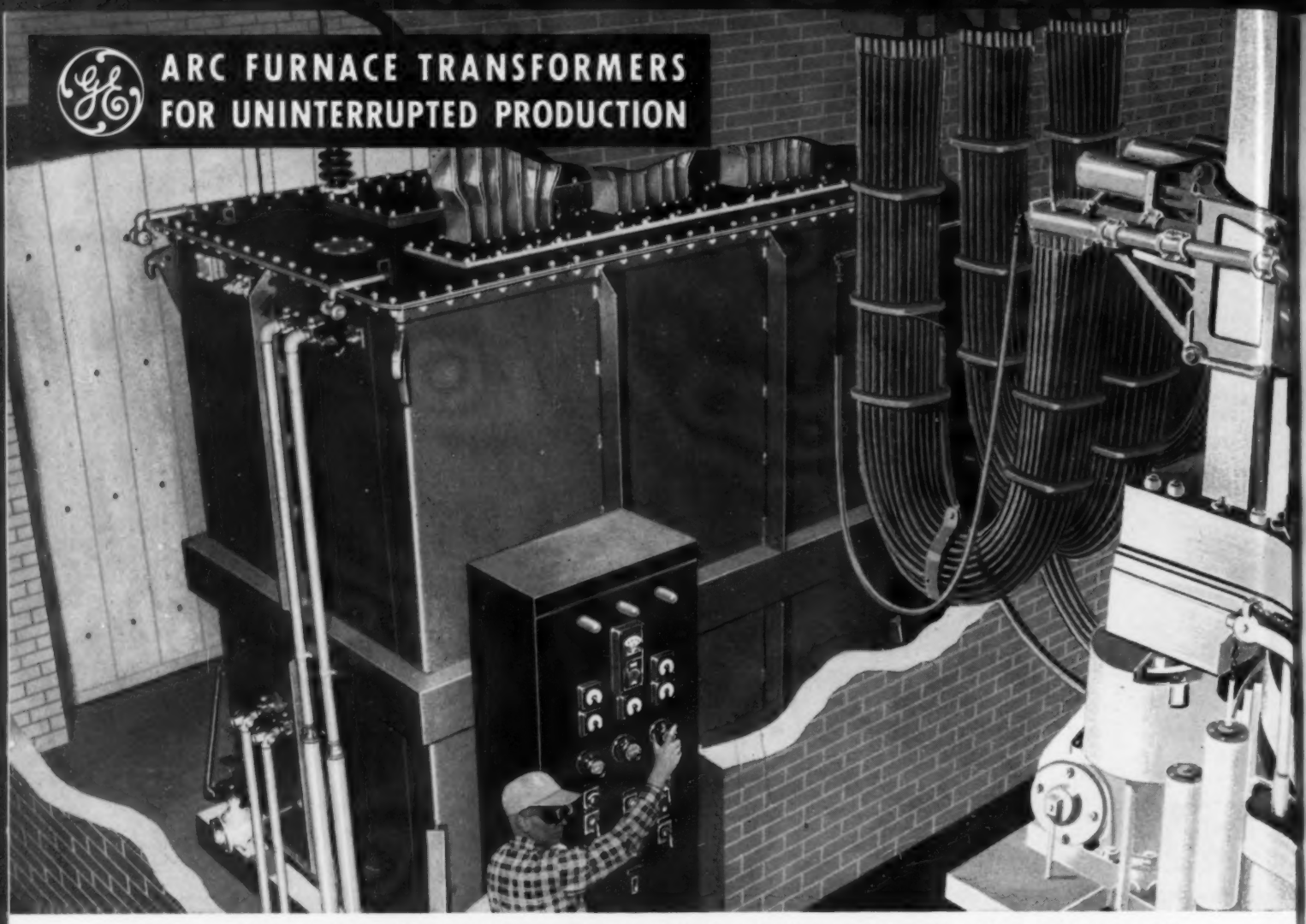
This new Split Wind Blowing Control is only one of the many Hagan advances in metallurgical furnace control. Ask your Hagan engineer for information on Hagan systems and Hagan components specifically designed for the control of open hearths, blast furnaces and heat treating furnaces.

HAGAN CORPORATION
HAGAN BUILDING, PITTSBURGH 30, PA.

HAGAN

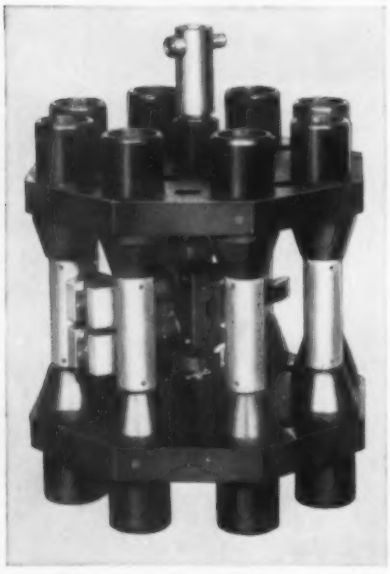
Systems and Components for: Boiler Combustion Control, Metallurgical Furnace Control, Process Control, Aeronautical Testing Facilities • Industrial Water Treatment • Chemicals for Water Conditioning

HAGAN SUBSIDIARIES: CALGON, INC. • HALL LABORATORIES, INC.



YOU CAN COUNT ON PRODUCTION CONTINUITY WHEN YOU INSTALL A GENERAL ELECTRIC ARC FURNACE TRANSFORMER.

Not one G-E tap-changer contact failure since wedge-type introduction in 1938



HEART OF TAP-CHANGER mechanism is the circular arrangement of contacts. Made of specially tin-plated copper, they have high current-carrying ability with low contact temperature, and a wedging action which assures good contact under all operating conditions.

Since the introduction 18 years ago of the General Electric wedge-type tap changer, no contacts have ever separated, carbonized, welded, or otherwise failed according to our records. This is another example of the outstanding record of reliability established by G-E arc-furnace transformers.

The tap changer itself is designed with liberal electrical, mechanical, and thermal safety factors. It can, in fact, withstand the full short-circuit current of the transformer without injury. Furthermore, a special safety interlock between tap-changer driving mechanism and primary circuit breaker prevents any chance of tap-changer operation under load. Because of the tap changer's reliability, it can be strategically located in the main tank close to the windings, thus permitting great savings in floor area.

Tap changers are only one of many features which make G-E arc furnace transformers your best bet for long-term reliability. Others include core-type construction with inherently strong circular-concentric windings, dust-tight bus-bar seal, and high-pressure-tested cooling systems.

For complete details contact your nearest G-E apparatus Sales Office or write for Bulletin GEA-6236 to General Electric Company, Section 422–27, Schenectady 5, New York.

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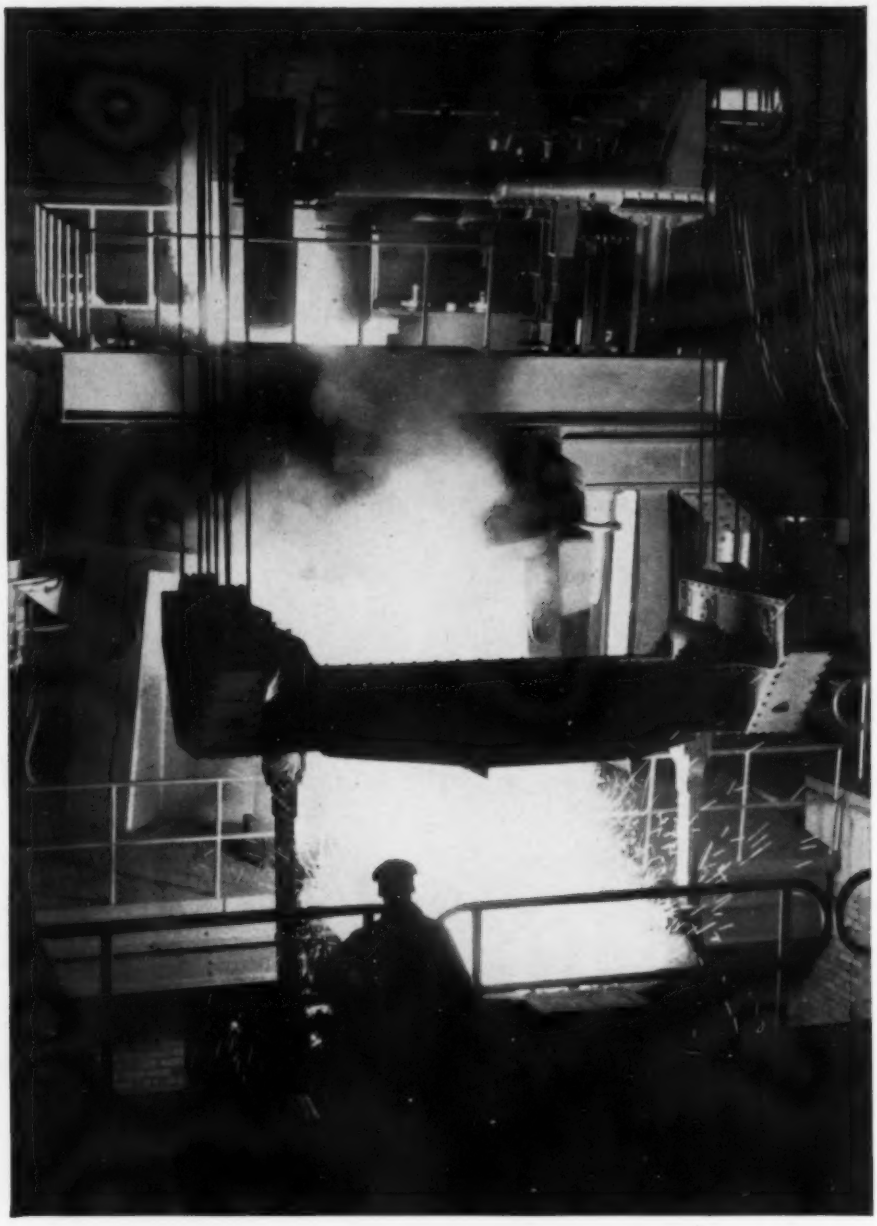
A 90-TON LECTROMELT* FURNACE



A second 100-ton furnace is now on order with Lectromelt

BUILT by Birlec, Ltd., licensee of Lectromelt Furnace Company, this 90-ton furnace has just recently been placed in production. So satisfactory is its performance that a second, larger Lectromelt Furnace has been ordered by Samuel Fox & Company, Ltd. of Stockbridge (near Sheffield), England.

Lectromelt Furnaces, because of their many outstanding features, have made friends all over the world. They're at work in 35 countries on melting, smelting, refining and reduction work.

A new Lectromelt Furnace may be your answer to improved plant efficiency. Catalog 9-A describes these furnaces. For a copy, write Lectromelt Furnace Company, 310 32nd Street, Pittsburgh 30, Pennsylvania (a McGraw Electric Company Division).

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*REG. T. M. U. S. PAT. OFF

MOORE RAPID

WHEN YOU MELT... *Lectromelt*

Surface Inspection of hot rolled coil rod and bars

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Youngstown Sheet and Tube Co.
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The severe requirements which steel used for cold forming must meet are being satisfied by better open hearth and rolling practices which are then followed by a complete surface inspection . . . .

▲ ABOUT thirty years ago, steel products such as bolts and nuts were, for the most part, hot forged and not subjected to any great tensile stresses in being forged or formed. These products were made from grades of steel such as 1015 and bessemer. Production was not too great and surface defects were not a major problem. However, with the increased production in the past three decades, introduction of automatic equipment, and the increasing quality requirements for new products, steel companies have had to increase the quality of steel that they produce.

In the hot forged products originally made, scale on steel reduced die life and as steels were heated to approximately 2100 F for forging, tensile strength in most cases would not exceed 5000 psi. However, with the introduction of cold heading and forming equipment, materials were required to withstand greater stresses than that required in hot forging processes. Steels were developed, such as resulphurized and higher carbon killed steels with tensile strength running 33,000 to 55,000 psi or greater.

Surface defects that were not detrimental in hot forging practices became a major problem to steel companies and trades. Among these surface defects were seams, laps, slivers and other mechanical defects. It became necessary to establish additional inspection and control practices to insure quality products reaching the trade.

Among the various types of surface defects, seams are the most troublesome in producing a quality product. In defining a seam it can be said that a seam is generally perpendicular to the surface when examined on a cross section. Seams are intermittent in nature and do not run continuously the length of product rolled. Seams usually result from a blow hole in the ingot which develops into seams when the ingot is rolled. Seams may also result from ingot cracks which may be caused by improper heating in the soaking pits, and may appear as deep seams on the rolled blooms. The seams in the blooms may be removed by automatic hot scarfing of the bloom before it is rolled into billets. This hot scarfing is generally performed on cold forming quality steels. Often the depth of seam on the blooms are too great to remove by hot scarfing, and the billets with seams are further conditioned by hand chipping or scarfing. If the material is chipped or scarfed too deeply the finished product may have laps and in many cases will have to be scrapped. Other causes of laps are improper heating and rolling practices. Material such as low carbon and resulphurized steels should be heated to and rolled at a temperature not less than 2130 F billet temperature. Some alloys are rolled at a lower temperature. Where material is worked too cold, overfills are encountered. Strains are set up in the steel, and cracking is encountered in cold working.

In addition to seams and laps, other surface defects such as slivers and mechanical defects have caused the customer to perform piece by piece inspection of his product. With the increase in production cost, on the part of steel customers, it became necessary for steel companies to provide a better quality product to the customer. In order to do this, the steel companies developed and put into use various types of testing practices. Some examples of these testing practices will be discussed as they apply to hot rolled rod and bars in

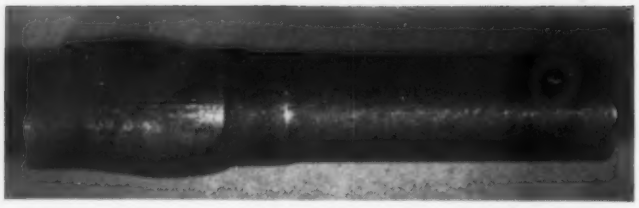


Figure 1 — The first cold forming operation on this stock started to open the seam.

Figure 2 — This seam is opened in subsequent heading operations.

coil form for use in cold heading and cold forming such products as bolts and nuts.

In speaking of coil rod we refer to material up to and including $^{47}/_{64}$ in. in diam and coil bar material $^{3}/_{4}$ in. and over in diam. To help portray how surface defects affect cold headed and cold formed products, several illustrations will be utilized. Figure 1 shows the opening of a seam during the first operation in cold forming of the stock. The upset is approximately 10 per cent completed. This opening will fracture more deeply in subsequent heading operation as shown in Figure 2. It is now apparent how cold heading distorts and fractures what might appear to be a light seam. Where any amount of this defect is encountered the manufacturer must piece inspect his product such as cold headed bolts and cold formed nuts. Some other examples of defective products are shown in Figures 3 and 4.

These cold formed nuts have distinct fractures that have originated from seams. Some inspection methods on the part of steel companies to assure a better quality of steel reaching the trade, are shown in Figure 5.

This shows the results of upset test practice. In upset test practice, a test piece from each coil, is cut to length approximately $1^{1}/_{2}$ times the diameter of the stock. The test piece and coil are tagged with identical numbers. The coils are placed in storage until the upset tests are completed. The cut to length test pieces are upset by hammer or press to $^{1}/_{2}$ of the cut length and where surface defects are found, the coil is sorted out by number and retested as before.

Another inspection practice is that of twist test shown on the test piece in Figure 6. For this type of test the piece is cut sufficiently long, usually about 12 in., to allow for clamping in the jaws of the twist test machine, which is similar to a lathe. The piece is twisted for a specific number of turns, as determined by the following formula.

No. turns equals twice the distance between the grips divided by ten times the rod diameter.

For example, on $^{3}/_{8}$-in. rod, with a 2-in. grip distance, the number of turns $= (2 \times 2) \div (10 \times 0.375)$ or $1^{1}/_{16}$ turns.

On material under 15 points carbon, $^{1}/_{2}$ twist is added. On material over 35 points carbon, $^{1}/_{2}$ twist is subtracted.

Another practice is "etch test," where a test piece is immersed in an acid solution for 10 to 15 minutes. The scale is pickled off the tests and the acid gets into any seam or lap and a black line is visible. The etch test is also used for determining the homogeneity of a given section worked on.

The upset, twist and etch test practices are time consuming operations as each coil rolled is subject to duplicate handling in order to obtain retests on coils indicating surface defects when tested. Mill production may be retarded where storage space is not available when coils are rolled and waiting on test and retest results.

A more efficient method of test inspection that permits the detection of surface seams, laps, slivers, and mechanical defects uses black light. As the coils move to the testing station from the rolling mill, a test piece is cropped from front and back end. The pieces are cooled in a water filled bosh tank, identified front

Figure 3 — Defects are bad in forming nuts.

Figure 4 — Note seams on flat edges of nuts.

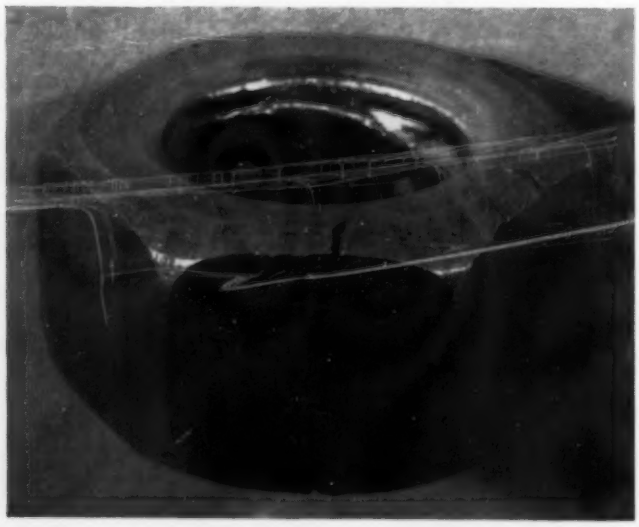


Figure 5 — Pressing a piece of stock in hydraulic press to one-half its original length will open up seams.

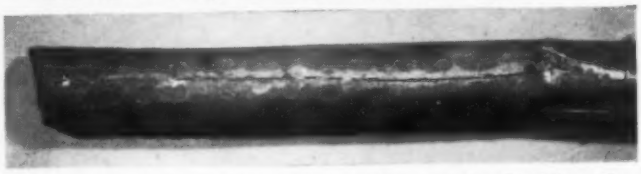


Figure 6 — The twist test is another method of locating defects.

Figure 7 — Inspection of the stock by means of a mechanical particle test and black light speeds up the testing operation.

and/or back, crop-test numbered in sequence, and dropped on a chute leading into the testing room. In the testing room, the pieces are magnetized while in a bath of carbon oil and metallic paste mixture. Magnetizing the piece causes the metallic particles suspended in carbon oil to form at the surface defect. These metallic particles glow when placed under the black light and are visible to the eye. This type of inspection is used on rods and bars $\frac{3}{8}$ to 1 in. in diam, for cold forming and heading on grades of steel in the carbon range 1008 to 1018, resulphurized steel 1108 to 1137 and heat-treated specifications 1035 to 1041. Steels such as alloy and high manganese grades are also inspected by this method. Where this black light type of inspection is performed, the trade benefits, as well as the steel mills, as a better quality of product leaves the steel mills, with less handling and better delivery. The customer complaints due to quality have been greatly reduced, using this method over other methods of testing, and a much lower percentage of material shipped has proven unsatisfactory. The type of equipment used is shown in Figure 7.

This figure shows the testing apparatus housed in a heated building. The test room is located adjacent to the coil delivery line between the mill coil reelers and the coil unolading station.

In practice, a good procedure for testing cold heading and scrapless nut quality rod and bars in coils is performed by one tester operator at the magnetizing and carbon oil metallic paste bath, who, after treating the test piece, hands it to the inspector at the black light who checks the piece under the light for surface defects.

It is no problem to identify the coils with surface defects as it takes only a few seconds to make the test. When a surface defect is indicated under the black light the inspector broadcasts the coil number, by means of a loud speaker system, to the inspector on the coil line. The coil identified has a red tag tied on as it moves to the coil unloading station. The test pieces from this red-tagged coil are twist tested to determine if the defect indicated under the black light is a seam or lap. Coils with red tags are removed from the line and kept separate from those coils which have tested satisfactorily. Retests are then taken from coil with red tags and another check is made under the black light. Should this test still show defects the coil is scrapped.

Figure 8 shows a test piece $1\frac{9}{32}$ in. round cut from a coil, apparently there are no surface defects visible. However, this same piece when subjected to the black light inspection is shown in Figure 9.

This seam showed up under the black light. When the seam was filed, its depth was found to be 0.011 in. deep.

SUMMARY

In conclusion, the trend to steels that can withstand the stresses required when they are used for cold heading and cold forming of various products has been satisfied by the steel companies in their open hearth practice, rolling practice, and a more complete method of surface inspection.

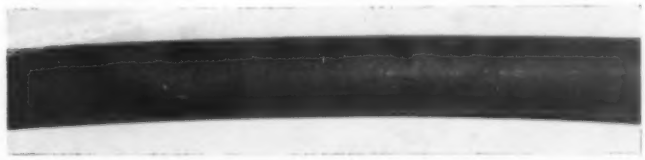
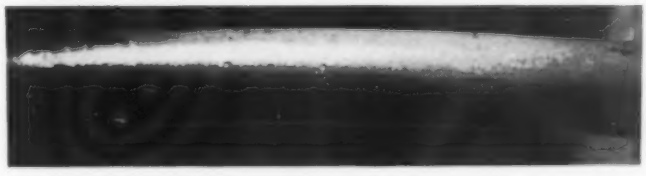


Figure 8 — This piece of stock has a seam which cannot be seen under ordinary light.

Figure 9 — The seam which cannot be seen in Figure 8 shows up clearly here under black light.



DISCUSSION

PRESENTED BY

CHARLES MITCHELL, Chief Inspector, McDonald Mills, United States Steel Corp., McDonald, Ohio

WILLIAM C. CAMPBELL, Assistant Superintendent, Merchant Mills, Campbell Works, Youngstown Sheet and Tube Co., Youngstown, Ohio

DON C. HORSMAN, Assistant General Superintendent, Continental Steel Corp., Kokomo, Ind.

FRED A. HORN, General Superintendent Hot Rolling Mills, Ford Motor Co., Rouge Plant, Dearborn, Mich.

WILLIAM A. MILLER, Superintendent Rolling Mills, John A. Roebling's Sons Corp., Roebling, N. J.

FRANCIS G. KREDEL, Chairman Bar Mill Committee, Republic Steel Corp., Cleveland, Ohio

Charles Mitchell: As far as the quality of the billets or semi-finished material being used to roll these rods or bars from, do you believe that hot scarfing or some other mechanical means is necessary to obtain this quality?

William C. Campbell: Yes, I do believe that hot scarfing is necessary. We perform this, not only the automatic hot scarfing in the blooming mill before it goes into billet form, but approximately 90 per cent of merchant mill material is further conditioned at the conditioning yard by hand scarfing or chipping.

Charles Mitchell: Also on your finished bars and rods, what percentage point would you consider rejection of an entire heat, from the percentage of defective tests that you obtained from that heat?

William C. Campbell: For example, in running a heat check, we have 20 per cent of the coil retested, and in making our retests we find the 20 per cent is still defective, we would scrap or divert the entire heat. Twenty per cent is our breaking point for scrapping or diverting a heat.

Charles Mitchell: That is assuming that the percentage of defective tests have a definite bearing on the quality of the heat throughout?

William C. Campbell: That is correct.

Don C. Horsman: I have seen in visiting the plant and from reports that our people bring back that they are doing an excellent job on this matter of eliminating surface defects at Youngstown.

I have two questions that have occurred to me.

I understood that your recommendation on rolling low carbon was the temperature be held to 2150 F, and my question is, how is that temperature measured, and where is it measured?

I have another question on the use of the black light tester with respect to the results obtained. Does that test indicate only a presence of the seam, or does it indicate also the depth or the possible difficulty that might be experienced from surface trouble because of that seam?

William C. Campbell: In answer to your first question, we use an optical pyrometer on material out of No. 2 stand, and 2150 F is the minimum temperature.

In answer to your second question, the black light does not measure the depth of the seam. However, with practice we have some operators that are pretty sharp in that they do determine the depth. This equipment has been in use for 14 years and it has never failed to indicate a surface defect.

Fred A. Horn: Our experience at Ford Motor Co. in the steel division is very similar in that the customers' requirements have necessitated definite improvement and change in both operating and inspection technique.

In order to assure our customers of good quality rods, all the 10 by 10-in. blooms are automatically hot scarfed and broken down into 5½-in. square billets which are sheared for re-heating on our 14-in. bar mill. The billets are later pickled, inspected and hand scarfed to remove the remaining defects such as seams, cracks or scabs. They are then broken down to the required billet sizes for the smaller mills.

All these billets are held for one hundred per cent piece inspection conditioned after rolling.

Conditioning is done by chipping. The billets are then sent to the 10-in. mill to be rolled into rods where samples are taken at the pouring reels to be checked for size and defects.

Coils are then put on the conveyor which transmits them to the shipping area. In this area, coils are again rigidly inspected and checked for size. The bad ends are cut off by a hydraulic shear and again given visual inspection.

All rods ½-in. and under are subject to the twist test and checked for laps and seams. On rods over ½ in. all samples are etched to assure a quality product. Samples are cut at the pouring reels and checked for surface dimension.

Defective coils are held for rework by cutting off additional coils rechecked for defects and repair or scrapped.

The etching solutions used are as follows: 50 per cent solution of hydrochloric acid in water and 30 per cent solution of nitric acid in water. The temperature of the solution should be at least 180 F, with approximately ten minutes in hydrochloric acid solution and 10 to 15 seconds in the nitric acid solution and back to a quick dip in the first solution and then rinsed.

This gives the sample a very bright etch so that the surface defects may easily be seen. This is slightly different than your practice, but we come up with practically the same results.

On a severe cold heating job where a severe upset is necessary, are the billets taken direct from the 18-in. mill or are they double converted on the 24-in. mill at Brier Hill plant?

William C. Campbell: The answer to that question is the billets are rolled directly from blooms at the Campbell Works. The blooms are hot scarfed and the billets are taken to the merchant mill for secondary conditioning.

Fred A. Horn: Is this secondary conditioning done by scarfing or by chipping?

William C. Campbell: That depends on the product. However, most of it is hand scarfing, 90 per cent.

Fred A. Horn: These billet sizes, I assume, range from 1⅞ to 3½-in. billets?

William C. Campbell: No, on that particular mill, the 9-in. mill, we roll 1⅞ and 2 9/16-in. billets.

Fred A. Horn: On the rod mill?

William C. Campbell: That is right. This is the 9-in. merchant mill.

Fred A. Horn: That is similar to our 10-in. mill. In hot scarfing these smaller billets do you have any trouble with twisting or bending the billets, or difficulty getting them through the furnace?

William C. Campbell: The only difficulty we encounter with billets is usually done by our crane handling. In secondary conditioning, bent billets are sometimes straightened by applying scarfing torch to back of billet.

William A. Miller: I would like to know what depth you allow on your laps and seams before the rod is discarded.

William C. Campbell: We will discard, after retest, any material where lap or seam is found—regardless of depth.

Francis G. Kredel: First of all, have you ever experienced on rods or bars of grades between 1018 and 1045 that after inspection you ship them on to a cold drawer and it is pickled and drawn and they find on the drawn surface a little spot, sliver, or scab which is awfully hard to determine in the first place and only through a heavy pickle will you find it on the bar before it is drawn? Have you ever experienced this, and if you have, what did you attribute it to?

William C. Campbell: Well, slivers can be caused by a poor job of scarfing, poor job of heating or dirty passes.

Francis G. Kredel: I am thinking of just minute scabs. In some cases we have considered it was caused by dirty passes. Several times when we moved over to clean passes, we got away from this condition, and I wondered what your experience has been in this problem.

William C. Campbell: We use high-pressure water at No. 3 stand, and that is usually effective in knocking off minor particles you are referring to.

Francis G. Kredel: In all this testing of coils, what type of equipment do you use to make your cuts?

William C. Campbell: We use a hydraulic shear, and it makes a tapered crop cut. We cut approximately a half ring off the front and back end of the coil.

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▲ EVER since steel plants have been built, maintenance men have been troubled with crane runway and crane maintenance problems. Constant efforts are required to repair cracked members, loose rivets, end support failures; and crane wheel binding on runway rails results in excessive wheel and rail wear. Difficulties are also experienced in keeping girder top chords working with their horizontal reinforcement, which may be walk plates, extended cover plates, or diagonal truss bracing.

Unfortunately, as new buildings have been built, the tendency has been to attempt to prevent future failure primarily by using the same or similar designs with somewhat heavier construction, an approach which does not always correct the real problem. Few texts discuss the subject, and relatively little attention has been paid to it at technical meetings until recently. However, two recent sessions which discussed the problem are the 1951 and 1954 National Engineering Conferences of the American Institute of Steel Construction.

The basic problem is due to the well known effect of Hooke's law which states that strain is proportional to stress within the proportional limit (which in the case of steel is about the same value as the elastic limit). See Figure 1. Although this principle is familiar to most engineering students, its practical effect and application are often forgotten. Consideration of its effect on girder design is the subject of this discussion, and a crane runway design which compensates for this effect will be described.

As a beam or girder is loaded, the beam deflects as illustrated in Figure 2. This deflection is accompanied by a number of other movements of the girder: (1) there is an overall shortening of the neutral axis which is unstrained under bending load because of the difference in length between the arc and the original straight line connecting the two ends of the girder at the neutral axis; (2) there is a lengthening of the tension side equal to the *average* tension along the outer fibre of the girder times the length divided by the modulus of elasticity (about 30,000,000 psi for steel); (3) there is a shortening of the compression side equal to the *average* compression along the outer fibre of the girder times the length divided by the modulus of elasticity; and (4) there is a rotation of the ends of the girder. Total movement may be obtained by properly combining these strains. These movements are often evidenced by loose rivets, particularly if such movements have not been considered in the design.

In addition to the movements or strains from Hooke's law, other important factors causing trouble are:

1. Spread of crane span.
2. Temperature strains.
3. Uneven column settlement.

These factors are also often neglected in the design or subsequent maintenance.

. . . . inattention to simple fundamental laws of engineering and mechanics may result in or exaggerate maintenance problems . . . .

MOVEMENT BECAUSE OF HOOKE'S LAW

These strains are appreciable, particularly in the longer spans. The total strain may be given by the formula:

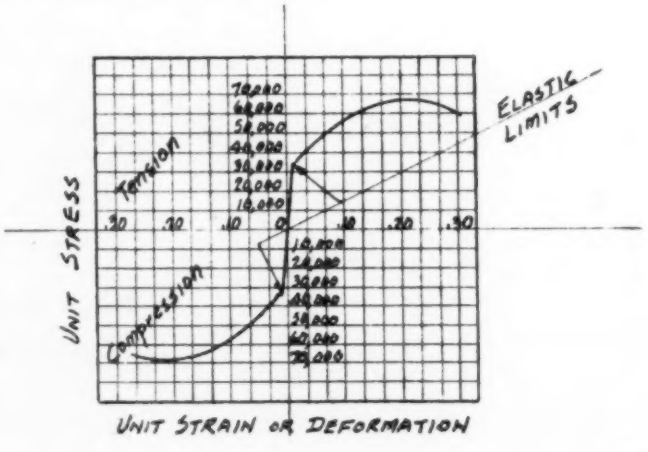
$$\text{strain (in.)} = \frac{\text{length (in.)} \times \text{stress (psi)}}{\text{modulus of elasticity (psi)}}$$

A runway girder which is 50 ft long, loaded at the center only, and stressed to 20,000 psi maximum at the center would have an elongation of the tension flange as follows:

$$\text{strain (in.)} = \frac{(600)\ \frac{20{,}000}{2}}{30{,}000{,}000} = 0.2 \text{ in.}$$

The stress is divided by two since if the beam is a simple beam, the stress at the end is zero, and the average stress is thus half the maximum.

Figure 1 — Stress-deformation diagram for structural steel. Note the straight line between the elastic limits which indicates that stress and deformation are proportional in this range.



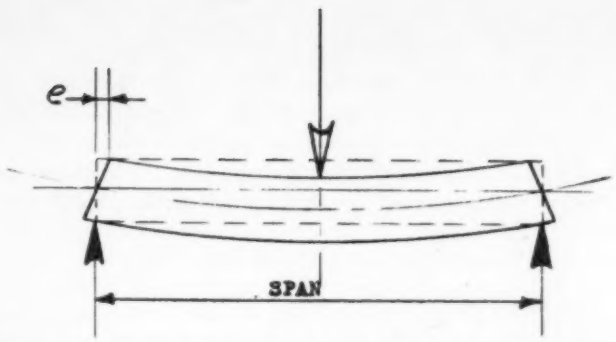


Figure 2 — Dotted lines show a straight unloaded beam. Full lines show exaggerated shape of a loaded beam. Note that the top flange shortens while the bottom flange lengthens — the length at the centerline does not change. Note particularly the outline change at the ends. Where loading changes from zero to a maximum repeatedly, this change in shape, or rotation at the ends, is a serious problem because the end connections tear themselves loose.

However, the relative deformation between the top and bottom flanges of a *symmetrical* girder will be double this because the compression flange will shorten as much as the tension side elongates; and this relative deflection for this case will be 0.4 in. In the case of a 125-ft girder this would be 1 in. Resultant lengths in this case would be 125 ft-0½ in. and 124 ft-11½ in. Both chords would be somewhat shorter than this because of the difference between the arc and chord lengths. If there is insufficient clearance between girder spans, the tension side would jam against the adjacent span as can be seen from Figure 2, causing a secondary direct and bending stress.

SPREAD OF CRANE SPAN

Crane girders are no different from runway girders and are also subject to movement because of strains. To partly compensate for this, "toeing in" has been a common practice. A set of girders which have lost their original camber may also have an increased span. Bronze wheel bushings will allow some sidewise leeway, which may not be obtained with anti-friction bearings.

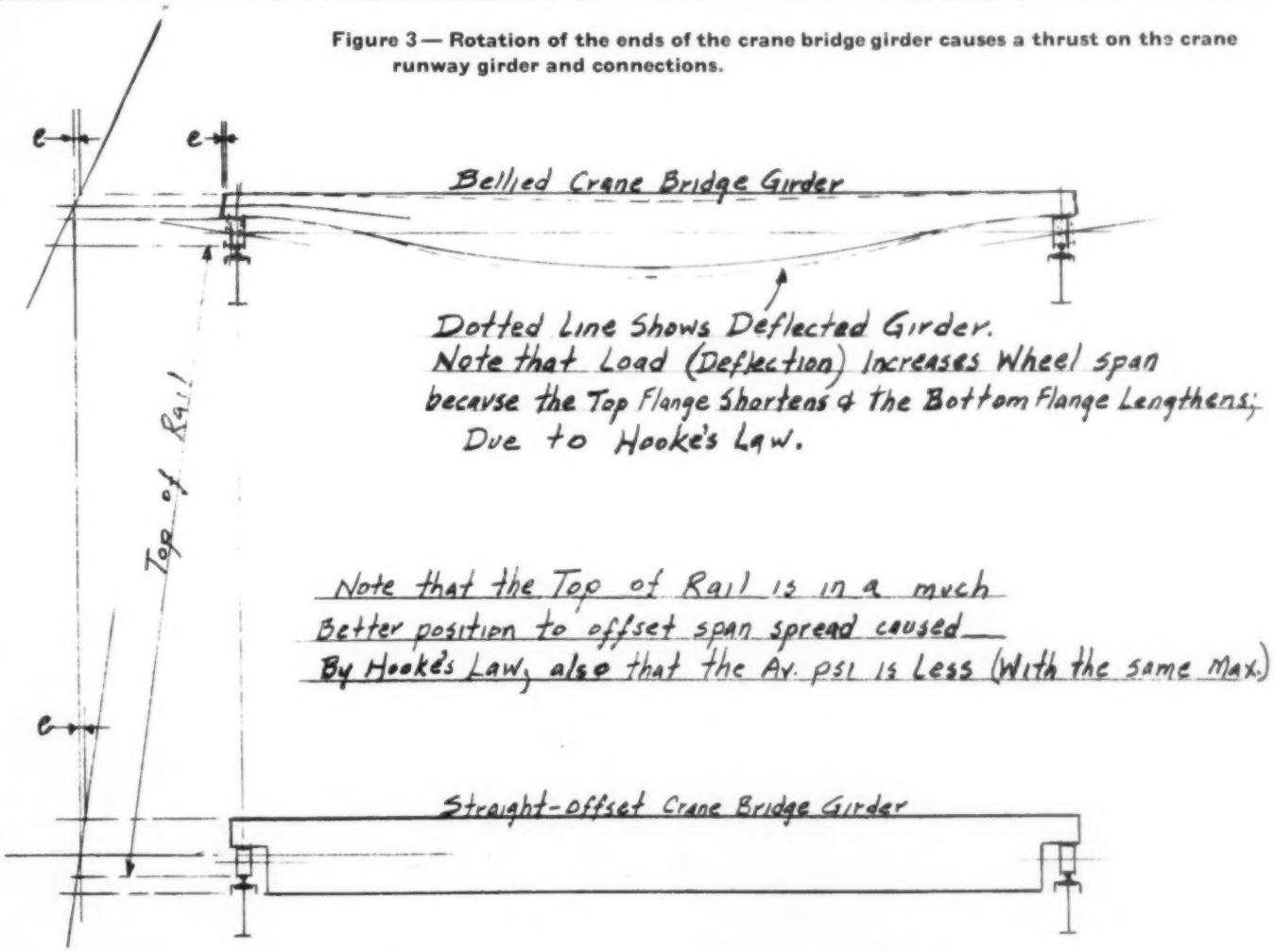
For a 100-ft span, fish-bellied girder with an average dead plus live load stress of 9,000 psi, the total difference in length of top and bottom chords would be:

$$\text{difference in strain (in.)} = \frac{(2)\ (1200)\ (9000)}{30{,}000{,}000} = 0.72 \text{ in.}$$

In this particular girder design, the wheel will move more than the end of the girder since the center of rotation is at the neutral axis. As the clearance between crane runway rail and wheel flanges is taken up, this will apply a lateral thrust to the girder which may be much larger than that due to deceleration of the trolley since the weight of the girder, trolley, and load is also a factor. Adjacent cranes of different spans and carrying various proportions of rated loads will also have an effect.

When the crane is in the middle of the runway span,

Figure 3 — Rotation of the ends of the crane bridge girder causes a thrust on the crane runway girder and connections.


e
e
Bellied Crane Bridge Girder
Dotted Line Shows Deflected Girder.
Note that Load (Deflection) Increases Wheel span
because the Top Flange Shortens & the Bottom Flange Lengthens;
Due to Hooke's Law.
Top of Rail
Note that the Top of Rail is in a much
Better position to offset span spread caused
By Hooke's Law, also that the Av. psi is Less (With the same Max.)
e
Straight-offset Crane Bridge Girder

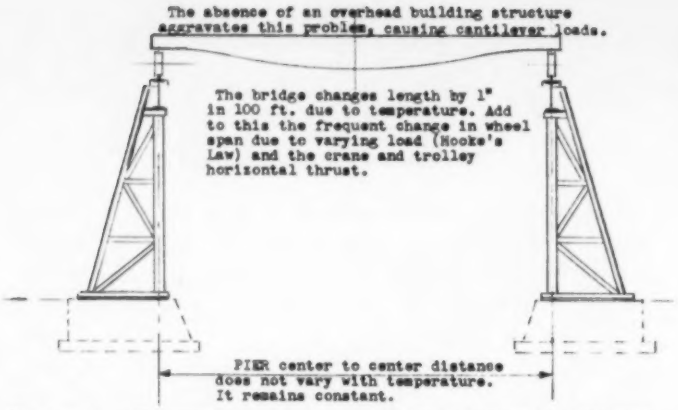

The absence of an overhead building structure aggravates this problem, causing cantilever loads.
The bridge changes length by 1" in 100 ft. due to temperature. Add to this the frequent change in wheel span due to varying load (Hooke's Law) and the crane and trolley horizontal thrust.
PIER center to center distance does not vary with temperature. It remains constant.

Figure 4 — Temperature is an important factor in outdoor cranes.

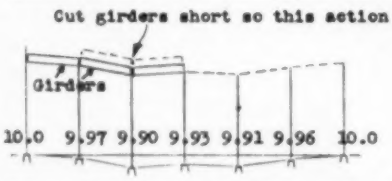


Figure 5 — Typical pattern for column and runway settlement is illustrated here. End columns do not settle as much as interior columns.

this horizontal thrust will probably only deflect the span, but when the crane is at the column, because of the stiffness at this point, this movement may account for cracked girder webs and loose top flange rivets.

The outward thrust is the worse case since it occurs with increasing crane load, whereas the inward thrust is less severe since it occurs with a decreasing crane load.

In the straight girder, where the wheels are located as in Figure 3, end rotation of the wheel is not quite as bad a factor since the wheel is located more closely to the neutral axis.

TEMPERATURE

The center to center distance between column piers does not change with temperatures. In a design of the type shown in Figure 4, with no overhead trusses, the building at the tops of the columns is free to move with temperature, both along and at right angles to the building or runway axis. In the case of an outdoor crane this problem is aggravated both due to the wider variation in temperature and lack of restraining influences present in building such as roof trusses and adjacent bays. With free expansion, movement of steel girder ends will be about 0.75 in. in 100 ft length per 100 degree F temperature change. Where restraint is present, this will cause stresses which are equal to the modulus of elasticity times the amount the girder is restrained from moving divided by the girder length.

UNEVEN COLUMN SETTLEMENT

Uneven column settlement is often present in mill buildings and an important factor in runway misalinement. See Figure 5. There are a number of causes, including differences in soil pressures, more work by loaded cranes in certain spans than others, and another cause is that end columns usually carry a lighter crane and building load. The designer has little control over this problem which may result in adjacent columns (only 20 ft apart) having as much as 2 in. difference in elevation. Some plants have actually jacked up columns of building in an attempt to get them back on line. Uncorrected, this problem may not be too serious for simple beams, but may be disastrous for continuous beams where, in some extreme cases, intermediate columns have been found hanging on the continuous girders. It is also difficult to rely on the continuity which may have been originally built into the girder connections. Deep girders are a worse problem than shallow girders as Figure 5 will illustrate.

COMBINED EFFECT

The various factors already described may act in combination to give worse effects than any single factor. Temperature differentials affect all members whether loaded or not. Movement, because of Hooke's law, affects loaded members only. Therefore, a tie which joins loaded and unloaded members cannot be expected to work together very long. A structural detail which ties an unloaded and loaded section together is shown in Figure 6. Unless designed to transfer such a load, this detail will not remain satisfactory.

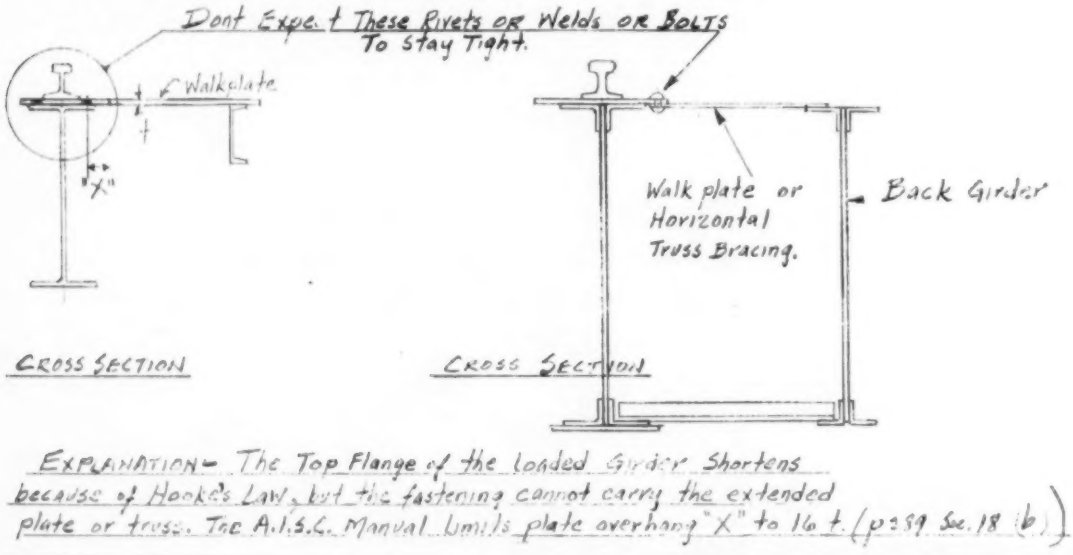

Dont Expect These Rivets or Welds or Bolts To stay Tight.
Walkplate
"X"
Walk plate or Horizontal Truss Bracing.
Back Girder
CROSS SECTION
CROSS SECTION
EXPLANATION- The Top Flange of the loaded Girder Shortens because of Hooke's Law, but the fastening cannot carry the extended plate or truss. The A.I.S.C. Manual limits plate overhang "X" to 16 t. (p 3-89 Sec. 18 (b))

Figure 6 — Connections between stressed and unstressed members cannot be brittle, but must allow some play if cracking is not to occur.

DESIGN

The usual way for the structural engineer to compute runway girder stresses is to assume that trolleys are

loaded to capacity at extreme end of bridge travel, and when more than one crane is on the track with bumpers touching and trolleys at the same end—then wheels are located on the runway girder to produce the maximum possible bending movement. An impact of 25 to 50 per cent is then added. This condition of loading is realized only a part of the time. Now move the trolley back toward midspan and see what happens to the wheel loads—at midspan they are about 60 per cent and at the far end only about 30 per cent. The facts are that the engineer deliberately makes the girders much heavier than otherwise in an effort to offset the well known high rate of wear and tear at the ends, and he does this by pyramiding the loads. As knowledge of a subject increases and the number of unknowns is reduced, one can safely use lower factors of safety.

Many concerns delay repairs until the crane operator refuses to ride the crane, others try to keep the end connections tight by servicing every few years—reaming out for larger rivets or bolts.

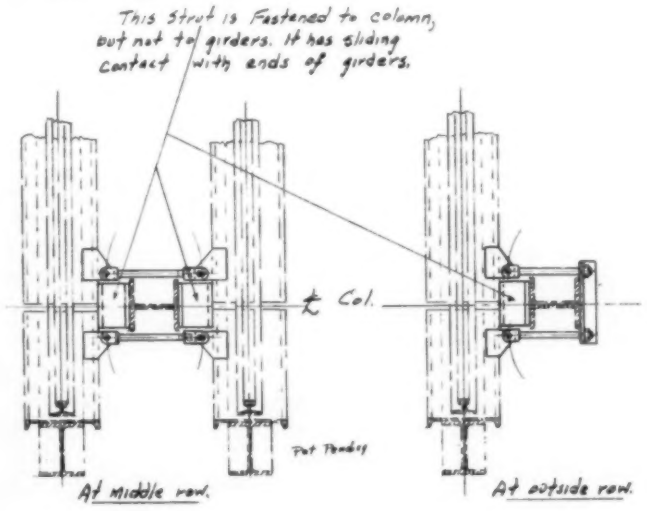
Most companies are not too interested in improved design, therefore the buyer or user should demand a better design and their engineers must learn to recognize a better design.

One solution to the problem is a design which allows the runway rail to float laterally on the girder a total distance of $\frac{3}{4}$ in. or $\frac{3}{8}$ in. on each side of the center. One design consists of two bolt rail clips which are used to hold or confine the rail within the limits. In the last 40 years, the runway track wheel flange spread has increased from the width of the rail head plus $\frac{3}{8}$ in. to width of the rail head plus 1 to $1\frac{1}{2}$ in. Allowing the rails and wheels to slide laterally partly offsets the span spread due to Hooke's law.

The runway rail should be continuous — bad rail joints shorten the life of the rail, girder, and the crane.

The straight—offset bridge girder is better than the old fish-bellied type because (among other advantages) it offsets much of the span spread caused by Hooke's law. In Figure 3 the horizontal displacement "e" is shown the same amount for both girders—the diagrams on the left side illustrates the advantage of the deep ended type whose span spread is less than the other.

Figure 7 — This flexible connection replaces or relieves the troublesome diaphragm. It is easy to install in a new or existing building.


This Strut is Fastened to column, but not to girders. It has sliding contact with ends of girders.
℄ Col.
Pat Pending
At middle row.
At outside row.

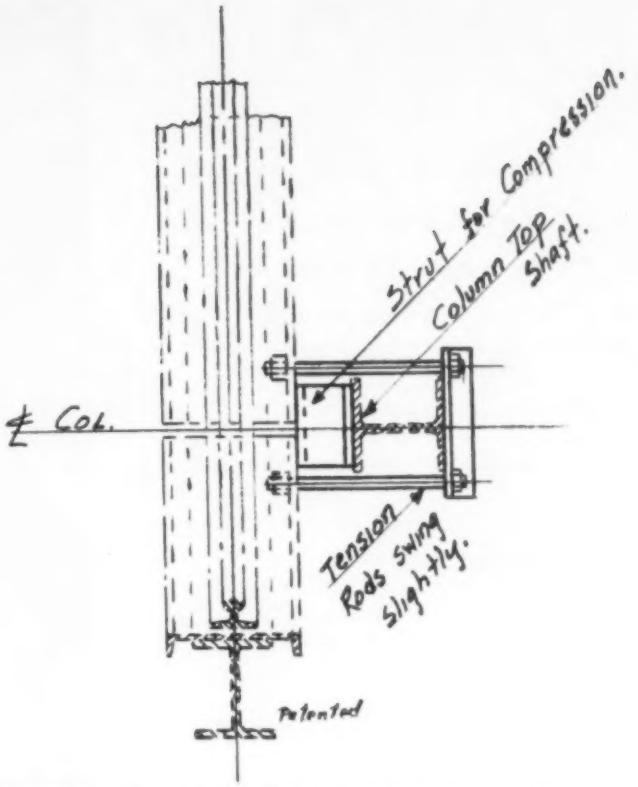


Figure 8 — This connection is simpler and, where it can be used, is more economical than that shown in Figure 7.

The horizontal thrust on the runway girders top flange is less with the straight type. Again this thrust varies directly with the span, and the average stress. So it is easy to understand why long spans are more difficult and expensive to maintain. An improved design that would entirely compensate for Hooke's law would be a blessing to crane users.

A number of designs may be used. Only two are illustrated in this article. See Figures 7 and 8. All accomplish the same end result. The two shown use rods which swing slightly to allow for the endwise movement of the top flange. No diaphragm is needed. All allow for the major displacements. The strut shown in Figures 7 and 8 is fastened to the column top shaft but has sliding contact with the girders ends. Figure 8 is the simplest design and may be used on short bays only. In Figure 7 the pivoted joints allow more free movement with less twist and wear. Other designs do not use swinging tie rods and may fit some conditions better.

All the designs have the following advantages:

1. They permit the runway girders top flange to float free endwise; the old designs try unsuccessfully to restrain the change of length caused by Hooke's law, temperature, uneven column settlement, etc., resulting in their tearing loose endwise and crosswise.
2. They provide an expansion joint at every column.
3. They hold the girder the proper distance from the column top shaft.
4. They take the trolley thrust and crane span thrust directly into the column top shaft and protect the girder web from being cracked while doing this.
5. Being inexpensive, they can be easily and cheaply installed in an old or new building.

Production operations with the top-blown oxygen converter have shown that this is a practical and economical method for making steel . . . . steel quality is good, production flow is even, and the process is flexible . . . .

Oxygen Steel in the United States

By C. R. AUSTIN

Manager, Oxygen Converter Dept., Kaiser Engineers, Division of Henry J. Kaiser Co., Oakland, Calif.

▲ THE production of steel in converters top-bloom with practically pure oxygen is steadily increasing. During the years 1949 to 1952, approximately 12,000 tons of steel were made in Austria on an experimental basis by two Austrian steel companies—Alpine-Montan at Donawitz and VOEST at Linz. Two-ton and fifteen-ton experimental vessels were used. Commercial production was started at Linz in November of 1952, and at Donawitz several months later. The two plants produced 365,000 tons in 1953. In November of 1952 the first rimmed steel ingot was made at Dofasco using the oxygen steel making process developed at Linz and Donawitz. A 3-ton vessel was used initially, followed by an 8-ton vessel in early 1954. Production in the present commercial units at Dofasco was started in the first week of October 1954. The McLouth Steel Corp. at Trenton, Mich., started production without previous pilot plant operation in December of 1954. The combined production of Alpine-Montan, VOEST, Dofasco and McLouth in 1954 is estimated by the writer at 750,000 ingot tons and it is also estimated that the combined production will approach 1,700,000 tons in 1955. A third converter will be in operation at Linz during the latter part of this year and Donawitz, which in the past has been limited in production by the size of its oxygen plant, will increase production in 1956 when their new oxygen plant is placed in operation; thus permitting three-shift operation instead of the present two-shift production. The production figures are illustrated graphically in Figure 1.

The oxygen converter plant at McLouth was laid out with the idea in mind of either duplexing the blown metal from the converters in the existing electric furnaces or of teeming ingots directly. The west wall of the oxygen converter building is common with the east wall of the electric furnace building. The crane runway height was set, essentially, on the basis of having sufficient height to transfer hot metal from the converters to transfer cars located at electric furnace floor level. Tracks for these transfer cars were extended out into the oxygen converter building.

The present oxygen converter building is about 1,100

ft long and 72 ft wide. It comprises six areas in the order named: from south to north, a flux unloading area in which ladles are also relined, a scrap handling area, an overhead bin area, a converter area, a ladle-servicing area and a teeming area. A general plan view is shown in Figure 2.

The fluxes are brought in by dump bottom railroad cars and are unloaded into open concrete bins below

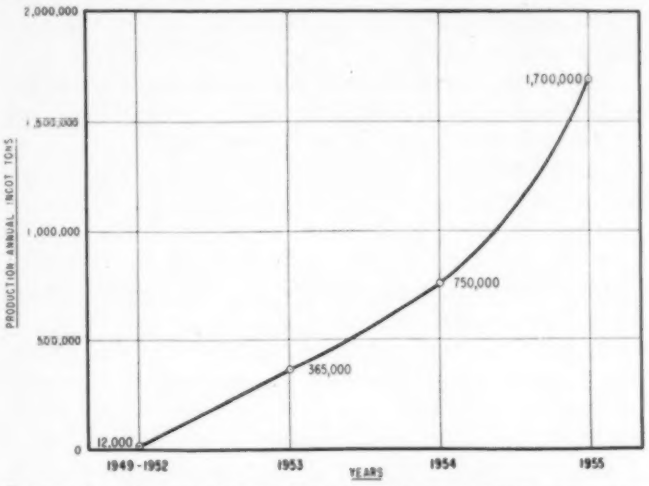


Figure 1 — Curve shows that top-blown oxygen converter steel production has increased very rapidly.

track level. In usual practice, fluxes are unloaded directly into large cylindrical "buckets" placed in the bin and, in turn, these buckets—holding perhaps 30 tons of fluxes—are transported to overhead storage bins near the converters. Occasionally, fluxes are unloaded into the bins below track level and the buckets loaded by clamshell bucket for transportation to the overhead bins.

In this same area are two ladle relining pits.

This area covers roughly 480 ft of length but it must be borne in mind that the majority of this area is occupied by material storage for the electric furnaces.

The fluxes are conveyed pneumatically from the overhead storage bins to weigh-hopper bins located above and adjacent to each converter. From this point the fluxes are fed by chute into the converters. Control of dumping of the fluxes is centered at the operator's pulpit.

Scrap is brought in by gondola cars entering through the side of the building approximately 480 ft north of the south end of the building. No provision is made for ground storage. All scrap preparation is done in the main scrap yard of the plant outside of the oxygen converter building. Space is provided for at least two gondolas of scrap in the 169 ft long area. Again, however, it must be pointed out that a considerable portion of this area is devoted to materials storage for the electric furnaces.

The overhead flux storage bin area is about 42 ft long and is situated between the scrap area and the converter area.

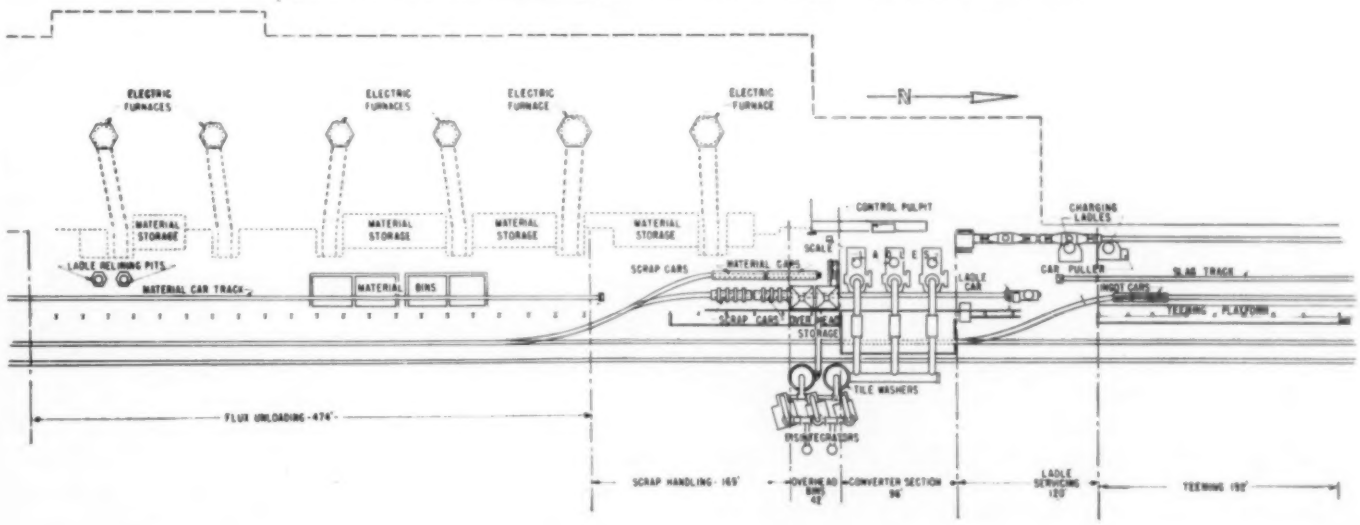
The vessel area is approximately 96 ft long and three vessels are placed in a north-south line in the area. The trunnion bearings are at approximately ground level and a pit is provided below each converter. An elevated transfer car in the pit holds both the slag pot and the steel ladle. It is cable activated and its movement is controlled from either the main operator's station located about 20 ft above ground level in the common wall between the oxygen converter building and the electric furnace building, or the localized control station at ground level at one corner of the pit.

The next area—approximately 120 ft long—is employed for patching of ladles, but not for relining. New stopper rods and nozzles are set in the area and minor repairs made. Stopper rods are heated in an oven in the adjacent electric furnace building. Hot metal enters in torpedo cars of 150-ton capacity on the west side of this area and two reladling pits are provided. Transfer of hot metal from the reladling pit to the ladle transfer car is made in the same area.

At the extreme north end—in an area approximately 192 ft long—is the teeming platform located on the east side of the area. The initial teeming platform was small and the teeming area was increased recently. Ingot cars enter through the east wall and leave by the north end.

Mold preparation and mold storage is outside of the converter area and is combined with the area provided for the requirements of the electric furnace shop. All of the ingots are top poured and bottom pouring is not practiced. Surface imperfections have not been a problem.

Figure 2 — Layout shows oxygen converter steel plant of McLouth Steel.



All stripping is done outside of the building and, like the mold storage and mold preparation, the stripper area near the soaking pits is utilized for both electric furnace and oxygen converter steel production.

Crane service is provided by three cranes operating on the same runway. The southern-most crane is responsible for handling the incoming fluxes and transferring them to the overhead storage bins near the converter. The crane also assists in servicing of ladles as the ladle relining pits are at the south end of the building. In addition, this crane also loads—by means of a magnet—scrap on the scrap charging car. The middle crane is used for handling the incoming hot metal from the reladling pit to a ladle transfer car of the self-propelled, self-tipping type which charges hot metal to the converter. This crane also assists in servicing ladles as stopper rods are set and minor repairs are made in the area between the converters and the teeming or north end of the building.

The north crane is used for teeming of the blown metal.

Behind the converters is the charging aisle. This aisle is about 25 ft wide. There is one track running lengthwise of the building. The hot metal car and the scrap charging car both use this common track; the hot metal car normally running from the north end to the converters, and the scrap charging cars from the southern section to the converters.

Slag pots are handled by the northern or the middle crane from the transfer car beneath each converter to cars on a track in the north end of the building for transportation to the slag dump. The slag pots are of steel and of 400 cu ft capacity sufficient to hold the slag from at least three heats.

Lime and limestone are received in dump bottom cars and transferred to overhead storage bins. Other fluxes are added at the converter mouth as necessary.

Owing to the extremely fine particle size of the fume generated in the oxygen converters, it was necessary to provide for an efficient gas cleaning system. A page was taken from blast furnace gas cleaning practice as a basis. In its present form, an appreciable length of the duct leading from the converter east to the remainder of the gas cleaning system is mounted on wheels on an inclined track and the entire length of this section can be raised and lowered at will. Immediately above the converter, the duct consists of a water-cooled section without refractories. Above this section the duct is refractory lined. Immediately below the water-cooled section is an annular pipe with holes drilled at intervals to permit water to be ejected into the gases going to the dust cleaning system.

At the upper end of the movable section of the hood is a two-pass "sparkbox" in which numerous water sprays are located. Dampers are provided in the ducts between the sparkboxes and the tile washer. The three ducts coming from the converters lead to a common main which takes the gases to the tile washer. From the tile washer gases go to a disintegrator, and from this disintegrator to a stack. The disintegrator is turbine driven and exhaust steam goes to the same stack as the effluent gases. The general effect is that of a cloud of steam issuing from the stack.

Unlike the two operating plants in Austria and the one in Canada, McLouth did not install a tar-dolomite brick plant as part of their facilities. From the beginning, commercial basic refractories purchased on the open market have been employed. As might be expected, the employment of American commercial refractories to this new process has presented problems; and to date, lining lives of 400 heats—obtained on experimental campaigns at the Donawitz plant in Austria with Austrian magnesite brick—have not been achieved.

Continuous progress is being made, however, and it is believed certain that American refractory manufacturers will meet the challenge presented.

The vessels at McLouth are of the eccentric type and are approximately 13 ft in diam and 22 ft high. The permanent lining is burned magnesite brick laid up next to the shell. The working lining is burned magnesite brick and is separated from the working lining by a layer of basic ramming mix.

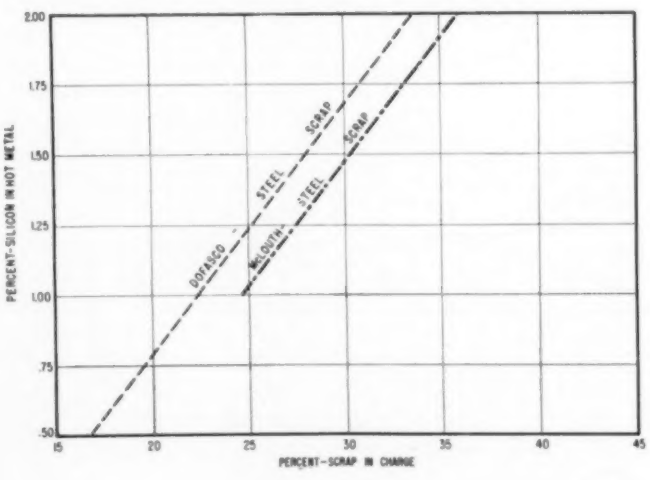
Initially, approximately 40 tons of metallic charge was used but as experience was gained, the metallic charge was increased and at the present time metallic charges of as much as 66 tons are used—but the usual limit is 60 tons. It is not usual practice, however, to start with this size of charge when the lining is new; the preferred initial charge is 48 tons.

The pouring practice from the converter vessel is different than that encountered in the usual bessemer operation. A pouring hole is provided in the side of the converter opposite the charging side. After completion of blowing of a heat, the majority of the slag is poured off through the converter mouth into the slag pot on the charging side of the vessel. The vessel is then turned to the opposite side in such a position that the slag remaining in the vessel is below the vessel mouth and steel runs out the pouring hole into the teeming ladle. After the metal is out, the remaining slag is emptied through the vessel mouth into the slag pot.

The lance is supported on a jib crane above the converter and the crane runway is above the top of the jib crane supporting the lance.

Initially, operation at McLouth was started by employing blast furnace hot metal and cold pig iron. Because of the "fuel value" of the cold pig iron, a larger percentage can be used than when steel scrap is em-

Figure 3 — Scrap used in charge can go up to 33 to 36 per cent as the silicon increases up to 2 per cent.



ployed. Figure 3 shows the relationship between the per cent of silicon in the hot metal and the amount of scrap that can be employed in the charge. About 25 per cent can be used at a 1.0 per cent silicon level, about 30 per cent at a 1.5 per cent silicon level, and about 36 per cent at the 2.0 per cent silicon level. For comparison purposes, the relationship between scrap and silicon content of the hot metal at Dofasco in Canada, as presented in the paper by F. J. McMulkin in the "Journal of Metals," April 1955 is given. Experience has shown that blowing times are slightly longer when cold pig iron is employed than when steel scrap is charged. The magnitude of the difference is approximately three minutes. When cold pig iron is substituted for scrap, approximately 5 per cent more cold pig iron can be used than when steel scrap is employed.

At the present time, the McLouth converters are being operated on a scrap charge of about 60 per cent of heavy mill scrap (crops) and 40 per cent light purchased scrap. The use of cold pig iron or steel scrap is dictated by availability of each and their relative costs.

Production at McLouth is rising month by month. As many as 32 heats per day have been made and this will increase as certain crane restrictions and materials handling problems are carried to conclusion.

As mentioned previously, scrap is charged to the converters from independently tilting boxes on the scrap car. Each scrap car has four boxes and each is of about 55 cu ft capacity. Light scrap—if employed—is charged first, followed by the heavy scrap. Hot metal is charged after the scrap.

As the silicon content is the primary factory controlling the amount of scrap employed, an anlysis of the hot metal in each torpedo car is made. Cycle time, of course, also has an influence on the amount of scrap that can be employed. Experience at Linz and Donawitz, however, indicates that the third charge in a vessel off the line for—say four hours—can carry the usual percentage of scrap or cold pig iron.

The analyses of the blast furnace hot metal average out as follows:

	Per Cent
Carbon	4.0
Manganese	0.99
Phosphorus	0.133
Sulphur	0.026
Silicon	1.12

This analysis is a typical one of that produced by many furnaces in the United States. Silicon contents up to 2.15 per cent have been handled successfully; phosphorus contents up to 0.17 per cent have been encountered without any trouble in reducing them to a desirable level.

In initial operations, test analyses of the blown metal in the converters were taken for control purposes, but an operating practice has now been established which is sufficiently reproducible that chemical analyses are made only on the finished product.

The flux portion of the charge is made to maintain about a 3 to 1 CaO to SiO_2 ratio in the final slag. Burned lime, limestone, mill scale, and aluminous material and/or fluorspar are employed. The exact additions of

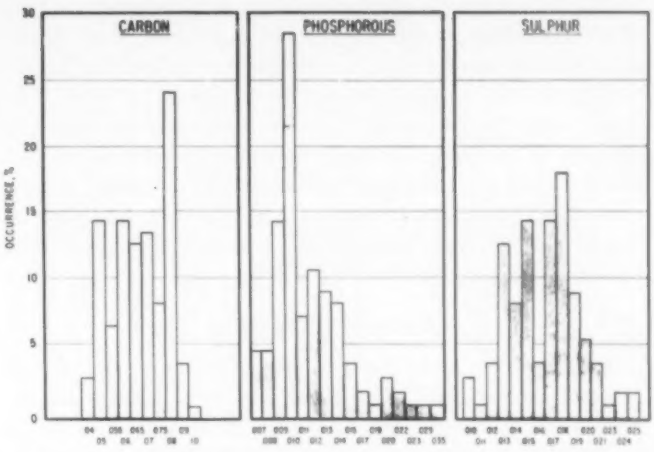


Figure 4 — Histogram shows distribution of carbon, phosphorous, and sulphur in steel produced in the converter.

each are governed by the percentage of silicon in the metal and the desired product analysis.

A representative slag analysis is as follows:

Ingredient	*Per Cent*
CaO	45-46
SiO_2	15-16
Total Fe as FeO	20
MnO	5.5
MgO	4.5-5.0
Al_2O_3	1.5-2.5
P_2O_5	1.1-1.5

As, with very few exceptions, rimmed grades are produced, all heats are taken down to the same carbon content as determined by visual observation of the flame.

Ladle additions are made in the usual manner.

Figure 4 is a histogram of risidual C, P, and S occurring in 100 heats picked at random from the period of May to September, 1955, in the finished steel. Manganese is not included as manganese is determined only in the final steel after ladle addition has been made. Spot tests, however, indicate that the manganese residual is approximately 20 to 25 per cent of that in the hot metal charged.

Control of the phosphorus is good with nearly all of the heats running below 0.015 per cent. The average figure is close to 0.012 per cent and lower values can be held, if desired, by appropriate slag practice.

Sulphur averages about 0.017 per cent in the final steel and has been no problem.

The oxygen plant at McLouth produces 99.5 per cent purity oxygen and, accordingly, the nitrogen content is low—usually in the range of 0.0015 to 0.0025 per cent—and no analysis from the time of initial start-up until the present has ever shown more than 0.0035 per cent.

With very few exceptions, the entire production at McLouth has been rimming steel top poured.

During duplexing operations, steel was made in the electric furnaces by using only 350 kwhr per ton with an appreciable decrease in time also.

As in other plants operating with the top-blown oxygen converter process, an even flow of steel to the rolling mill has been experienced resulting in low reheating

costs. For the same chemistry, the steel is more ductile than open-hearth steel and a decided preference for it has been shown by the cold reduction mill at McLouth to which the entire production is being routed. The process has shown itself to be flexible in being able to employ as metallic charge, either cold pig iron or steel scrap based on the relative economics of using one or the other in conjunction with hot metal. In general, the age hardening characteristics of the steel have been found equal to or better than other grades.

ACKNOWLEDGMENT

Acknowledgment is made to Ivor Bryn, vice-president of operations; Paul Lindberg, Jr., general superintendent of hot metals division; J. Horsley, superintendent of the oxygen converter shop; and many other personnel at McLouth Steel Corp. for their assistance in the preparation of this paper.

DISCUSSION

PRESENTED BY

J. R. MILLER, Executive Vice President, Ramseyer and Miller, Inc., New York, N. Y.

C. R. AUSTIN, Manager, Oxygen Converter Dept., Kaiser Engineers, Division of Henry J. Kaiser Co., Oakland, Calif.

GEORGE I. BOTTCHER, Chief Engineer, Allegheny-Ludlum Steel Corp., Brackenridge, Pa.

J. R. Miller: First, what are the limitations to the process—and specifically in relation to single slag operations—when the phosphorus in the hot metal is around and over 0.2 per cent? Second, has there been any correlation established between the amount of scrap which the process can handle and phosphorus content of the hot metal, similar to that shown in the curve presented for silicon?

C. R. Austin: In answer to the first question, the process to date has been in commercial production with phosphorus contents of less than 0.3 per cent. There have been certain practices developed in Germany with iron of very high phosphorus content up to 1.8-2.2 per cent where a double slag process has been employed enabling the process to be used with that range of phosphorus.

With regard to the second question, I do not have a direct correlation of phosphorus content versus scrap addition similar to the material on silicon, but the amount of scrap can be increased as the amount of phosphorus is increased.

George I. Bottcher: You mentioned that it was necessary to increase the teeming area in the oxygen steel shop. Is this because more metal is now poured direct into ingots? What per cent of the oxygen steel is duplexed in electric furnaces?

C. R. Austin: Up until approximately March 1, almost the entire production of the oxygen converter plant was being duplexed. In the month of March, duplexing was practically stopped and from March on it has practically all been poured directly into ingots. The original teeming area was a rather short one and five bays equivalent to about 120 ft was added some two to three months ago.

1956

AISE CONVENTION AND EXPOSITION

CLEVELAND PUBLIC AUDITORIUM

CLEVELAND, OHIO

SEPTEMBER 25, 26, 27, 28

Developments in Scalebreaking and Continuous Pickling Lines

By J. I. GREENBERGER
Group Engineer
United Engineering & Foundry Co.
Pittsburgh, Pa.

Application of scalebreaker to continuous pickling lines gives increased productivity with minimum acid immersion length . . . . acid requirements are reduced, strip speeds are increased, and costs are reduced . . . . existing lines can be converted to use the equipment . . . .

▲ OXIDES or scale formation produced on carbon steels as a result of the hot rolling operation must be completely removed prior to any subsequent cold rolling. This assures high quality cold rolled surfaces with a minimum of porosity.

Many factors affect the specific type and distribution of these surface oxides and, as pickle line operators well know, a considerable variation exists in ease of pickling of the various oxide combinations. Modification of hot rolling practice, particularly hot coiling temperatures, have important consequences. Steel chemistry and tightness of hot coil also affect hot rolled scale formation.

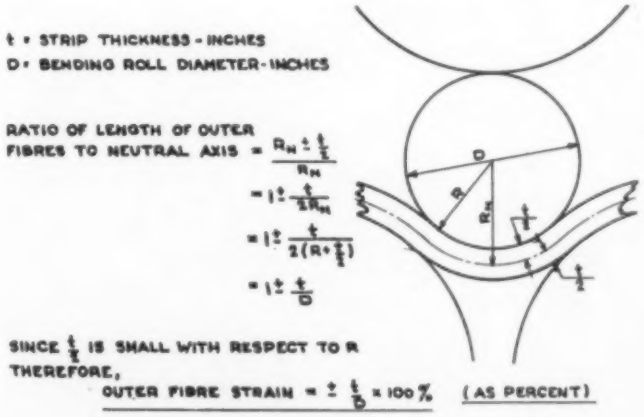
Relatively recent recognition of the necessity for proper scalebreaking prior to strip entry into the pickling baths has been one of the few changes applied to the fairly standardized design of continuous pickling lines. Addition of more length of acid bath and higher mechanical operating speeds are among the remaining design changes.

It is generally recognized that the pickling process in hot sulphuric acid baths starts as an acid action at the zone of demarcation between the base metal and the innermost oxide layer resulting in the lifting off of scale particles. While acid bath temperature and concentration may be varied to most effectively pickle a given oxide condition, it is obvious that a tight unbroken oxide layer will result in a difficult pickling problem. A scalebreaking process to crack the oxide layer prior to pickling will result in the formation of many passageways for acid travel to the metal and oxide interface and thus provide most rapid oxide removal.

Many mechanical scalebreaking processes, all dependent on the relatively low ductility of the oxides, are possible. Cold reduction has been quite commonly used for scalebreaking type 430 stainless steel. Continuous stretching would require massive equipment to effectively scalebreak the hot rolled strip thickness. At the present time, flexing operations seem to offer the most direct approach to the problem of working the surface oxides above their yield points.

To correlate the relationship between surface strain and resultant effectiveness of scalebreaking a series of tests was conducted. The amount of strain imparted to strip surfaces during a flexing process may be expressed as plus or minus $\frac{t}{D} \times 100$ per cent, where "t" is strip

Figure 1 — Outer fibre strain is approximately equal to $\frac{t}{D}$


t = STRIP THICKNESS - INCHES
D = BENDING ROLL DIAMETER - INCHES
RATIO OF LENGTH OF OUTER FIBRES TO NEUTRAL AXIS = $\frac{R_N \pm \frac{t}{2}}{R_N}$
$= 1 \pm \frac{t}{2R_N}$
$= 1 \pm \frac{t}{2(R+\frac{t}{2})}$
$= 1 \pm \frac{t}{D}$
SINCE $\frac{t}{2}$ IS SMALL WITH RESPECT TO R
THEREFORE,
OUTER FIBRE STRAIN = $\pm \frac{t}{D} \times 100\%$ (AS PERCENT)
D
R
R_N
t
$\frac{t}{2}$

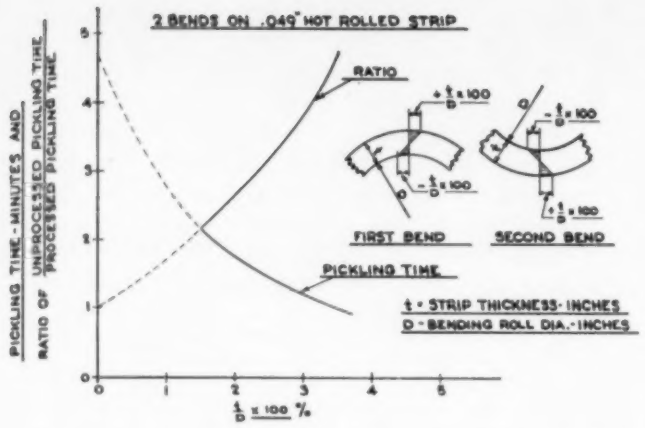
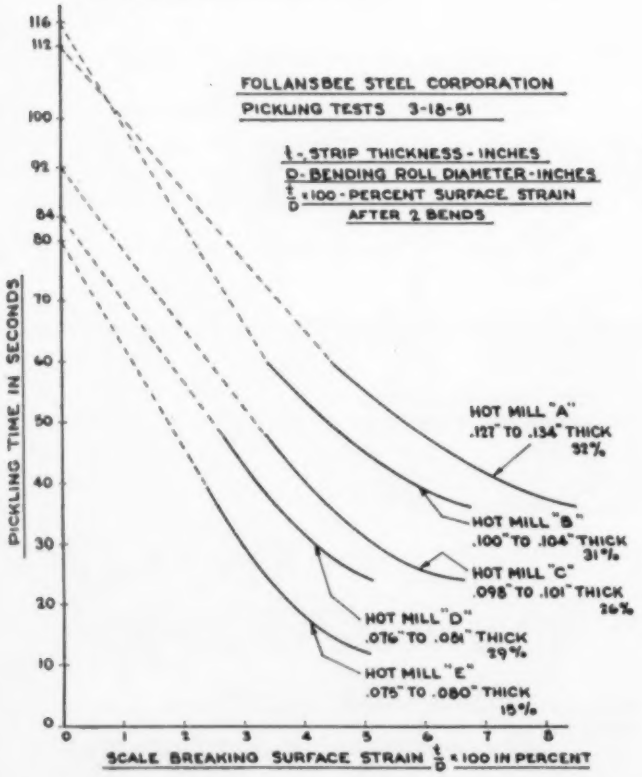

2 BENDS ON .049" HOT ROLLED STRIP
PICKLING TIME - MINUTES AND RATIO OF UNPROCESSED PICKLING TIME / PROCESSED PICKLING TIME
RATIO
+ t/D x 100
- t/D x 100
FIRST BEND
SECOND BEND
PICKLING TIME
t = STRIP THICKNESS - INCHES
D = BENDING ROLL DIA. - INCHES
t/D x 100 %

Figure 2 — Increasing outer fibre strain reduces pickling time.

thickness and "D" is roll diameter around which strip is flexed. Derivation of this expression is shown in Figure 1. On the basis of a series of laboratory tests, the effectiveness of a second reversed flexure of strip which results in surface motions of twice $\frac{t}{D} \times 100$ per cent was established and the typical relationship shown in Figure 2 was obtained.

Another important series of test results are shown in Figure 3. Hot rolled strip specimens from five different hot mills were subjected to varying amounts of strain and the relative pickling rates established. Several facts become apparent, first the differences in hot rolling practice, chemistry, etc., resulted in greatly different oxide conditions and required pickling times and, second, there was a basic similarity in response of all

Figure 3 — Pickling tests on five different mills show effects of the straining of the outer fibre and oxide variation on the pickling characteristics.


FOLLANSBEE STEEL CORPORATION
PICKLING TESTS 3-18-51
t - STRIP THICKNESS - INCHES
D - BENDING ROLL DIAMETER - INCHES
t/D x 100 - PERCENT SURFACE STRAIN AFTER 2 BENDS
PICKLING TIME IN SECONDS
HOT MILL "A" .127" TO .134" THICK 32%
HOT MILL "B" .100" TO .104" THICK 31%
HOT MILL "C" .098" TO .101" THICK 26%
HOT MILL "D" .076" TO .081" THICK 29%
HOT MILL "E" .075" TO .080" THICK 15%
SCALE BREAKING SURFACE STRAIN t/D x 100 IN PERCENT

hot rolled oxides to the mechanical scalebreaking process. As the $\frac{t}{D} \times 100$ per cent or severity of strain was increased, the required pickling time decreased. These tests and studies led to the design and building of the processing scalebreaker.

Having established and confirmed the necessity for imparting certain minimum $\frac{t}{D} \times 100$ per cent or strain relationship to physically remove an appreciable amount of scale, and also crack the remaining adhering scale so that rapid acid action and pickling occurs, the practical problem of designing and building a flexible scalebreaker was then studied. For thin hot rolled gages, say from 0.060 to 0.080 in., a 2 per cent strain or $\frac{t}{D} \times 100$ per cent per bend would require 3 to 4-in. diam curvature in the strip. Existing types of flexing units had flexing rolls of somewhat larger diameters and no positive means to force the strip to take the curvature of the flexing roll. The solution to this problem and one of the important features of the processing scalebreaker is the nested roll construction indicated in Figure 1. The flexing rolls have full radial support, and adequate bearing capacity is obtained, as well as assurance that strip

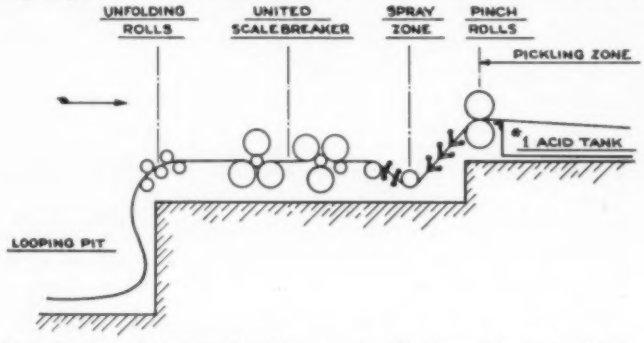


Figure 4 — Schematic shows a typical scalebreaker location in a continuous pickling line.

curvatures correspond to bending roll diameters. Flexing rolls can be changed rapidly and a range from about 3½ in. minimum to 6 in. diam maximum have been engineered into the general scalebreaker designs. Hydraulic holddown arrangements for each of the two flexing sets provide for variable holddown pressures as well as quick opening means.

Operating experience on three units has more than confirmed theoretical expectations. Excellent scalebreaking is obtained without resorting to the smallest flexing roll diameters, and flexing roll life between grinds is about a month, while backing rolls are in about four to five months between grinds. No operator is assigned to the scalebreaker, and its rugged mill type design has meant trouble-free operation. The work hardening due to a proper scalebreaking operation is of no significance when a cold rolling operation follows the pickling. Cold mill operators are unable to detect any rolling differences. Product to be deep drawn from the as hot rolled and pickled condition would require dummying through any scalebreaking means to avoid the age hardening effects following even a minimum of cold work.

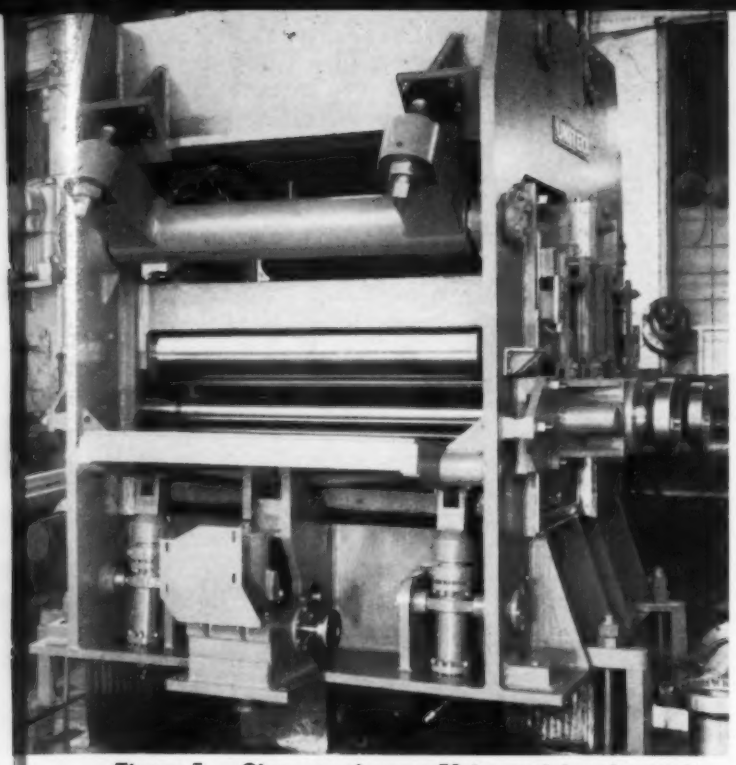


Figure 5 — Close-up shows a 56-in. scalebreaker unit.

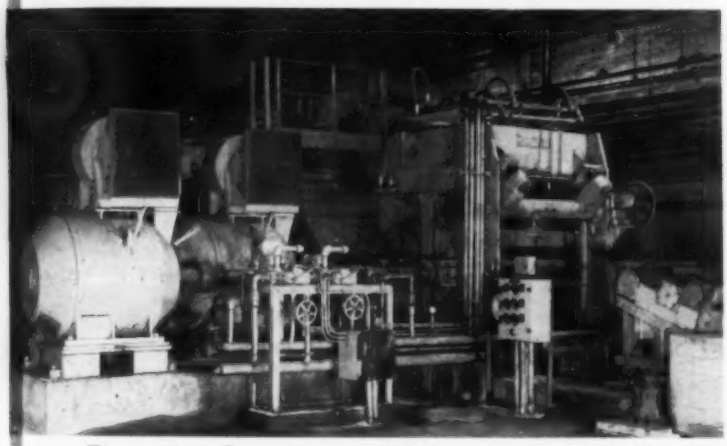
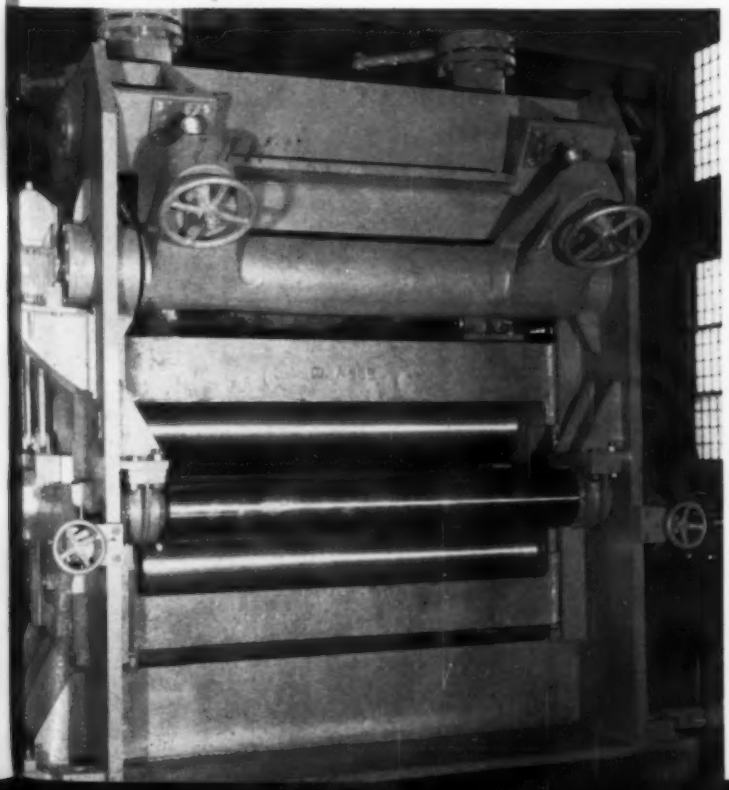


Figure 6 — Speeds up to 400 fpm are reached with this 56-in. scalebreaker.

Figure 7 — This 70-in. scalebreaker was installed in a French plant.



The latest operating unit, a 56-in. machine for about 50-in. maximum width strip has been in operation since September 1954 in a continuous pickling line. It was located as shown in Figure 4 after the entry looping pit and was followed by a hot water spray, then by the conventional drag pinch rolls and the acid baths. In this lower speed location, the minimum amount of connected power is required. Also, because of the steady lower speed, mechanical maintenance is at a minimum. The hot water spray serves the dual purpose of washing off all loose oxide and preheating the strip so that acid action starts immediately. All loose oxide removed by the combination of proper scalebreaking and hot water spraying results directly in reduction of acid consumption and acid disposal requirement. Figures 5 and 6 are shop and installation views of this machine. Operating results have even exceeded preliminary test results. When pickling a reversing hot mill type of oxide which previously with other scalebreaking and pickling means was run at speeds of 80 to 90 fpm, using this scalebreaker in conjunction with a longer acid immersion section, speeds of 350 to 400 fpm are attained. An interesting full scale field test was recently conducted on this 56-in. machine on a group of test coils from a continuous hot strip mill. With the first two pickling compartments of a total of four flushed with hot water, pickle zone speeds of 400 fpm still yielded clean pickled strip. Actual acid immersion times of less than 24 seconds yielded cleanly pickled strip after passage through the scalebreaker.

The next scalebreaker will be installed in an existing continuous pickler in a French plant. The scalebreaker will process up to 62 in. wide strip at speeds up to 500 fpm. Shop views of this new scalebreaker are shown in Figures 7 and 8.

Having pointed out the great possibilities of pickling speed-up by installing a proper scalebreaker, it becomes necessary to examine the continuous pickling line and ascertain whether full advantage can be taken of the ability to pickle in very short times.

Operators are all familiar with the conventional units and their functions in the entry end of a continuous pickler, namely first, the feeder; then the cropping shear; then the flash welder and finally the flash trimmer. All of these functions take place ahead of the looping pit and during each joining operation, there is no strip thrown into the looping pit. From the basic concept that the total stoppage time of the entry end joining operation plus the "throw in" time of the newly welded coil must equal the running time through the

Figure 8 — Side view of 70-in. scalebreaker which is designed to operate at speeds up to 500 fpm.

pickle zone of a coil length running at some average pickle zone velocity, the following relationship is obtained:

$$V_p = \frac{V_E}{\frac{V_E \times t}{L} + 1} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where V_p = pickle zone velocity ..... fpm
V_E = entry zone velocity ..... fpm
t = total down time for joining ..... min
L = coil length ..... ft

This is a fundamental relationship which is quite interesting in its ability to show methods of increasing V_p, the pickle zone velocity or mechanical speed which can be steadily maintained.

Let us examine typical continuous pickling line conditions to establish average mechanical pickle zone velocities:

Case I — Single Entry Looping Pit — An Older Installation

Assume

$V_E = 600$ fpm
$t = 2\frac{1}{2}$ min
$L = 400$ ft

$$V_p = \frac{600}{\frac{600 \times 2\frac{1}{2}}{400} + 1}$$

$V_p = 126$ fpm

Thus 126 fpm is the maximum average mechanical speed which can be maintained for these typical conditions.

Case II — Single Entry Looping Pit — A Newer Installation

Assume

$V_E = 1200$ fpm
$t = 2\frac{1}{2}$ min
$L = 800$ ft

$$V_p = \frac{1200}{\frac{1200 \times 2\frac{1}{2}}{800} + 1}$$

$V_p = 253$ fpm

Thus 253 fpm is the maximum average mechanical speed which can be maintained for these typical conditions.

Examination of the basic formula for V_p shows that three factors may be varied, namely, L, V_E and t. Coil length L is usually established by the hot mill layout and major changes would be involved to increase coil lengths from the mill. Older hot mills with smaller slabs and close mill spacing meant coil lengths of 300 to 600 ft, while newer mills range between 800 to 1200-ft coil lengths and the very latest mills have 1600 to 1800-ft coil lengths. Another means of increasing coil lengths to the continuous pickle lines would be a separate coil build up line complete with welding and trimming features. Normally, cost of this separate operation with its space requirements for coil storage would rule out such an operation. Entry zone velocity V_E has ranged up to speeds of 2000 fpm, but there are indications that speeds should be retained at about 1200 fpm or less in order to get a minimum of detrimental strip scratching or marking when throwing steel into the looping pits. Looping pits should be wet for even this 1200 fpm speed. The factor of total downtime lends itself to considerable modification, since it represents in a single entry looping pit arrangement the total time for feeding, cropping, welding and trimming. Analysis of these time components eventually led to the development of the patented double entry looping pit scheme shown in Figure 9.

Separation of the single entry zone into two independent zones, the first including feeding and shearing, and the second including welding and flash trimming, permits coincident performance of various functions. Note in Figure 9 that while the welding operation is being performed the tail end of the second coil is thrown into the No. 1 pit and a new coil is fed, front end cropped and passed over the No. 1 pit ready for entry into the welding zone. As the tail end of the preceding coil leaves the No. 1 pit, the front end of the new coil is fed up to the welder, the No. 1 pit carryover means withdrawn and the remainder of the trailing coil fed into the No. 1 pit, etc. Operation of the No. 2 pit following the welder is conventional. As a consequence of this arrangement, the downtime limiting the pickle zone velocity becomes that of the welding and flash trimming zone which averages somewhat less than one and a half minutes.

Let us re-examine our typical assumed pickling line conditions on the basis of a double entry looping pit.

Case III — Double Entry Looping Pit — An Older Installation

Assume

$V_E = 600$ fpm
$t = 1\frac{1}{2}$ min
$L = 400$ ft

$$V_p = \frac{600}{\frac{600 \times 1\frac{1}{2}}{400} + 1}$$

$V_p = 192$ fpm

Thus 192 fpm is the maximum average mechanical speed which can be maintained for these typical conditions.

Case IV — Double Entry Looping Pit — A Newer Installation

Assume

$V_E = 1200$ fpm
$t = 1\frac{1}{2}$ min
$L = 800$ ft

$$V_p = \frac{1200}{\frac{1200 \times 1\frac{1}{2}}{800} + 1}$$

$V_p = 369$ fpm

Thus 369 fpm is the maximum average mechanical speed which can be maintained for these typical conditions.

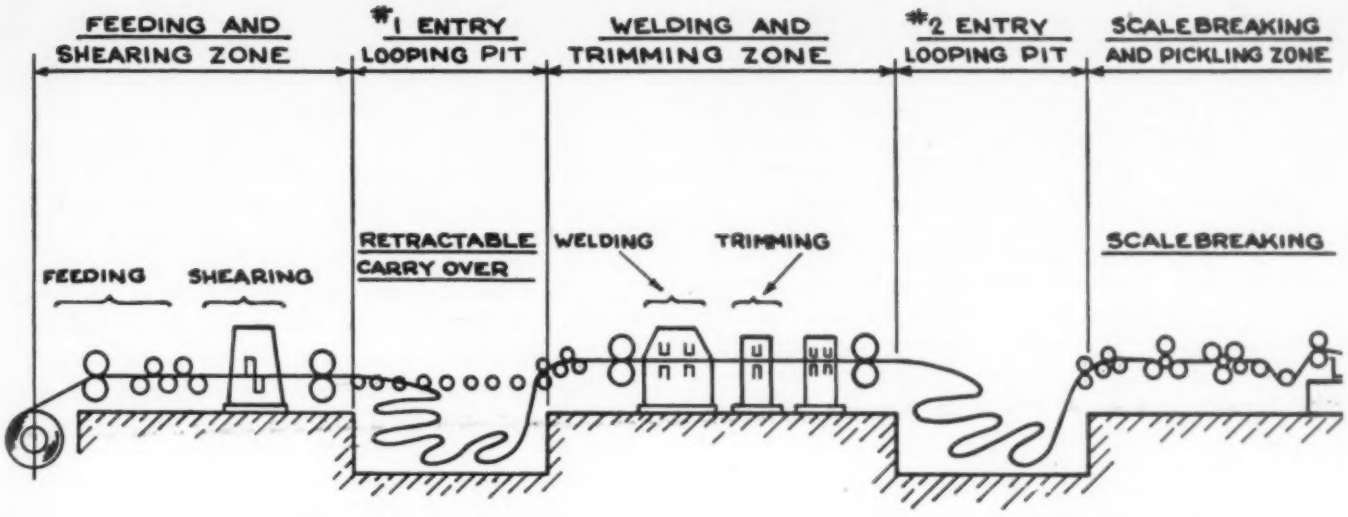


Figure 9 — This schematic shows a double entry looping pit arrangement for continuous pickling lines.

Summarizing our examples in Table I:

TABLE I

Case No.	Line	Entry pit arrangement	V_E (fpm)	L (ft)	t (min)	V_p (fpm)	Increase in V_p (fpm)	Increase in V_p (Per cent)
I	Old	Single	600	400	2½	126	—	—
III	Old	Double	600	400	1½	192	66	52.4
II	New	Single	1200	800	2½	253	—	—
IV	New	Double	1200	800	1½	369	116	45.9

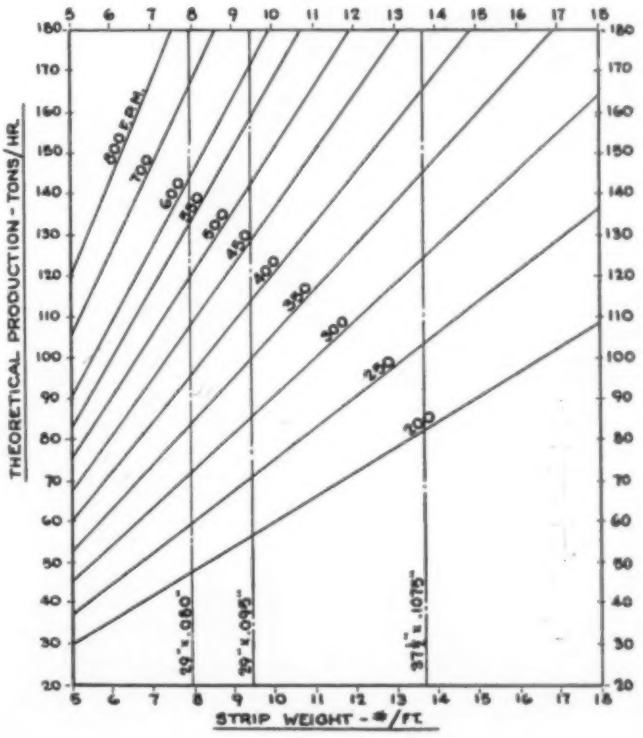
It is evident from Table I that a double entry looping pit pickler arrangement for an older mill with short coils would yield about 52 per cent more production with the same entry zone speeds, while for a newer mill with longer coils, some 46 per cent more production would be obtained with the double entry looping pit arrangement. While these production increase figures apply to the specific assumed conditions of L, V_E and t, many studies of actual installations indicate that at least 35 per cent production increase can be obtained if the double entry looping pit arrangement is substituted for the conventional single entry looping pit arrangement.

Studies have been made which show that in existing pickle lines, conversion to the double entry looping pit arrangement is possible with a minimum of interference with operation. Two existing pickle lines are being converted to this double entry looping pit arrangement and active investigations with several plants indicate additional conversions will materialize shortly. One conversion study on an old line with very short coils includes some entry zone speed up as well as the double entry looping pit arrangement and expected production increase approaches 100 per cent. Improvements or modifications to the present welding and trimming operations such as perhaps combining of these operations to eliminate one of the two positioning operations will reduce welding zone downtime and permit higher pickle zone speeds.

For maximum productive efficiency, the delivery ends of continuous pickling lines should also be engineered for minimum downtime. Addition of a cropping shear after the side trimmer with which welds may be cropped and threading through the side trimmer eliminated, use of a delivery looping pit, and provisions for fast coil discharge will all contribute to increased production.

Examination of pickling line tonnages including the most recent installations is quite interesting and provides practical corroboration of the necessity for fundamental revision of continuous pickle line thinking. Figure 10 shows theoretical productions for various average strip weights for average maintained pickle zone speeds. Using the present typical 63 per cent production efficiency for continuous pickling lines, it becomes apparent that the 60 to 110 tons per hour high

Figure 10 — Theoretical production for various average strip weights at average pickling zone speeds are given by diagram.



production picklers are actually averaging the low to moderate pickling zone speeds predicted by the above theoretical considerations. With the greatly increased production potentialities made available by proper consideration of the downtime elements as well as other less critical factors, it would seem that future continuous pickling line designs will be radically modified. The nomograph of Figure 11 was developed to provide a quick means of establishing maximum average mechanical pickle zone speeds for all combinations of conditions.

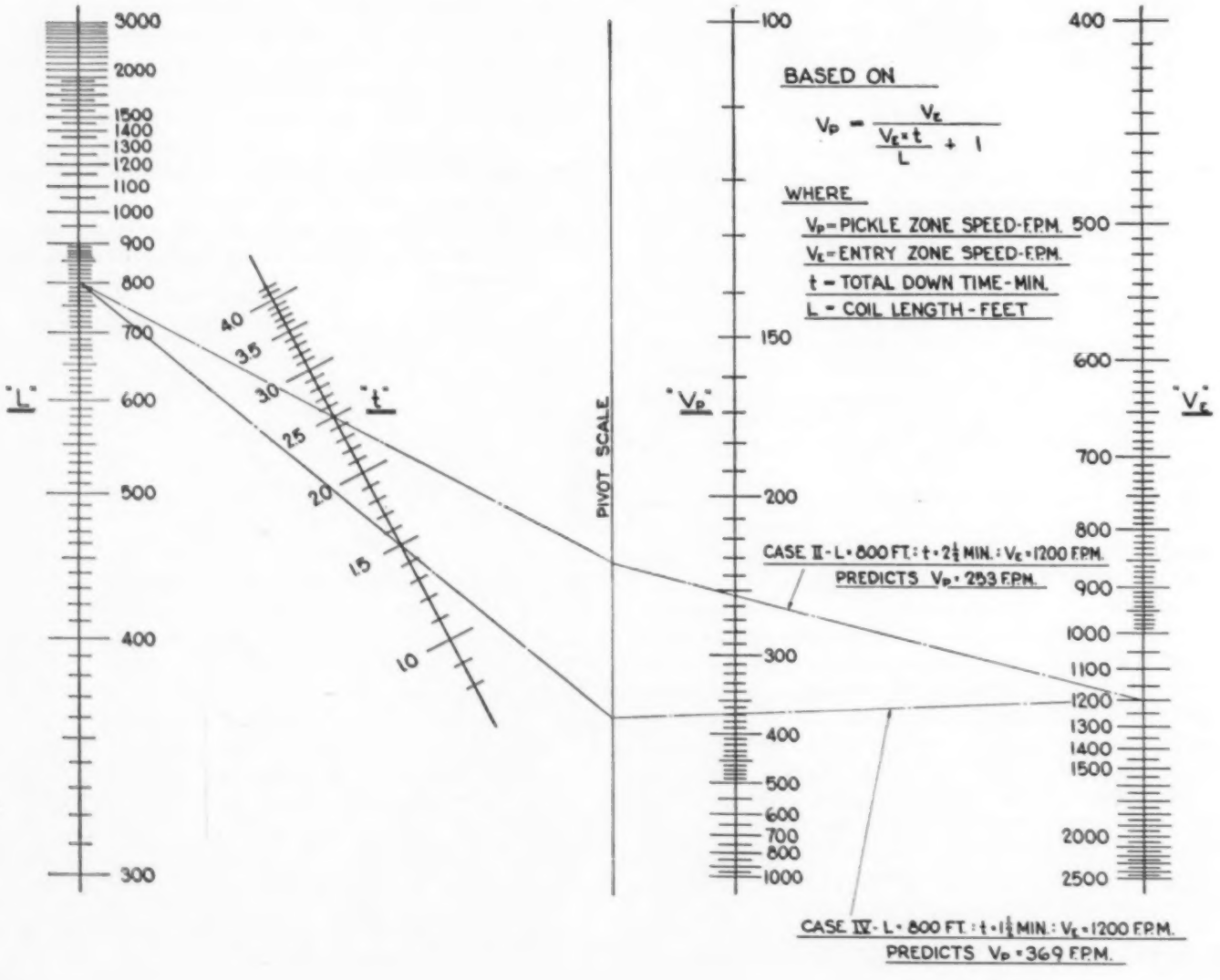
Having established potentialities for much higher mechanical pickle zone speeds for given coil lengths, the related scalebreaking and pickling problem should again be examined. Required length of acid tanks or acid immersion is correlated with pickle zone speed and surface oxide condition. As shown in Figure 3, the required acid immersion time is affected by the type of oxide as well as proficiency or degree of scalebreaking.

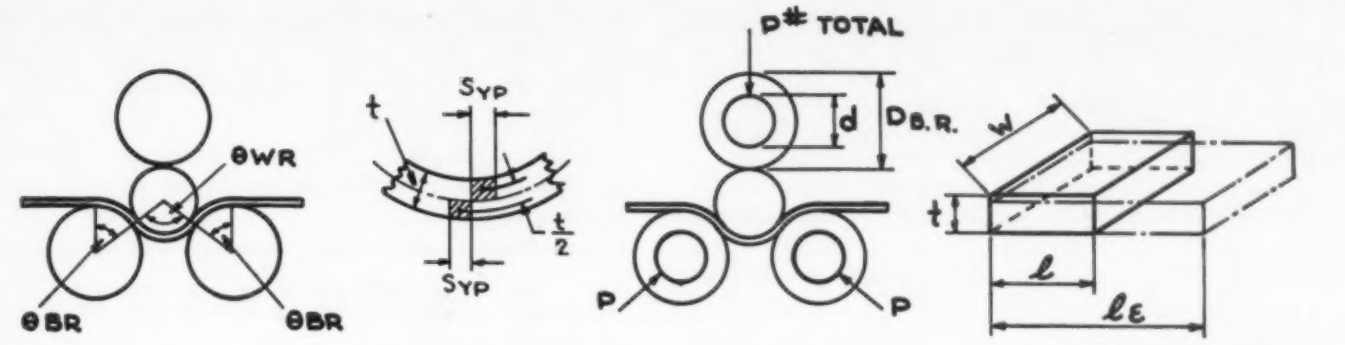
Full scale field test results confirm laboratory tests and show that after passage through the scalebreaker, acid immersion times of 25 to 30 seconds or less are more than sufficient for clean pickling of continuous hot strip mill type of oxides. Thus, for this type of oxide, with 30 second pickling, 200 feet of acid should be sufficient for 400-fpm pickle zone speeds, 300 feet of acid for 600 fpm, etc. From the pickling standpoint, higher strip speeds mean more agitation of surface liquid layers and replenishing of fresh acid and more efficient pickling and even lower acid immersion times should result.

Reversing hot mill type of oxides as well as older close coupled continuous hot strip mill oxides require somewhat more acid immersion times, but in all cases the use of proper scalebreaking incorporated into continuous pickle lines will permit use of minimum acid immersion length, running at maximum mechanical pickle zone speed and most economical operation.

This paper has attempted to trace the development and background of the scalebreaker as well as its engineering principles; has shown the advantages of applying the scalebreaker to continuous pickling lines; has shown the mechanical speed limitations of a single entry looping pit pickler and the controlling mathematical relationship; has shown the increased productivity of a double entry looping pit arrangement and pointed out the practicality of conversion of existing lines. It has suggested reduced acid immersion times where the scalebreaker is used; and in general has recommended solutions to the two problems of scalebreaking and increased mechanical pickle zone speeds.

Figure 11 — This nomograph provides a quick means for establishing maximum average mechanical pickling zone speeds.





A - BENDING WORK RELATIONSHIP | B - FULL PLASTIC CONDITION | C - BEARING FRICTION WORK RELATIONSHIP | D - ELONGATION WORK RELATIONSHIP

Figure 12 — Sketches show work relationships in new processing scalebreaker.

APPENDIX I

To develop the power requirements for the processing scalebreaker, let us examine the single bend set illustrated by Figure 12-A.

Letting:

θ_{WR} = angle of wrap around bending rolls . . . . radians
θ_{BR} = angle of wrap around backing rolls . . . . radians
S_{yp} = tensile yield point of strip material . . . . . psi
t = strip thickness . . . . . in.
W = strip width . . . . . in.
D_{WR} = diameter of bending roll . . . . . in.
D_{BR} = diameter of backing rolls . . . . . in.
T = time . . . . . min
V = strip velocity . . . . . fpm
d = bearing diameter — effective . . . . . in.
μ = bearing coefficient of friction . . . . dimensionless
P = total holddown pressure . . . . . lb
$S_{yp\ ave}$ = average tensile yield point of strip material . psi
l = initial length of strip . . . . . ft
ϵ = strip elongation . . . . . dimensionless
B. M. = bending moment . . . . . lb-in. or lb-ft

The total work involved may be separated into the bending work, the friction work and elongation work. These will now be individually considered.

Bending work and energy — Assuming full plastic conditions existing in the strip throughout its flexing passage around the bending and backing rolls, the required internal strip bending moment is illustrated by Figure 12-B and is:

$$B.M. = S_{yp} \times \frac{t}{2} \times \frac{t}{2} = \frac{S_{yp} \times t^2}{4} \quad \text{lb-in. per in. width} \quad (2)$$

$$\text{or, } B.M. = \frac{S_{yp} \times t^2 \times W}{48} \quad \text{lb-ft — total} \quad (3)$$

An angle of wrap around the backing rolls corresponding to a given length of arc may be expressed in terms of the bending roll by the following:

$$\theta_{BR} = (\theta_{WR})\left(\frac{D_{WR}}{D_{BR}}\right) \quad \text{radians} \quad (4)$$

Now the work done by a couple acting through any angle is the product of the couple times the angle in radians. Therefore, the work of flexing the strip around the bending rolls is:

$$W_{WR} = \frac{S_{yp} \times t^2 \times W}{48}(\theta_{WR}) \quad \text{ft-lb} \quad (5)$$

The work of flexing the strip around the two backing rolls is:

$$W_{BR} = \frac{2 \times S_{yp} \times t^2 \times W}{48}(\theta_{BR})$$

$$= \frac{2 \times S_{yp} \times t^2 \times W \times \theta_{WR} \times D_{WR}}{48 \times D_{BR}} \quad \text{ft-lb} \quad (6)$$

Adding (4) and (5), the total work in each bend set is:

$$W_T = \frac{S_{yp} \times t^2 \times W \times \theta_{WR}}{48}\left(1 + 2\frac{D_{WR}}{D_{BR}}\right) \quad \text{ft-lb} \quad (7)$$

Now a given interval of time may be expressed as:

$$T = \frac{D_{WR} \times \theta_{WR}}{24 \times V} \quad \text{min} \quad (8)$$

The bending energy in each bend set is:

$$E_B = \frac{W_T}{T \times 33{,}000}$$

$$= \frac{S_{yp} \times W \times V}{6{,}600{,}000}\left(\frac{100\,t}{D_{WR}}\right)t\left(1 + 2\frac{D_{WR}}{D_{BR}}\right) \quad \text{hp} \quad (9)$$

Therefore, for a two bend processing scalebreaker, total bending energy is:

$$E_{TB} = \frac{S_{yp} \times W \times V}{3{,}300{,}000}\left(\frac{100\,t}{D_{WR}}\right)t\left(1 + 2\frac{D_{WR}}{D_{BR}}\right) \quad \text{hp}$$

or:

$$\frac{E_{TB}}{W \times \frac{V}{100}} = \frac{S_{yp}}{33{,}000}\left(\frac{100t}{D_{WR}}\right)t\left(1 + 2\frac{D_{WR}}{D_{BR}}\right)$$

hp per in. per 100 fpm (10)

Friction work and energy — The resultant radial pressures on the bottom backing rolls of the bending set illustrated by Figure 12-C are dependent on the roll diameter relationships, but for the purposes of this mathematical development, let us assume all backing rolls have the same radial loads.

Total friction work in each bend set is therefore:

$$W_{FR} = (3\mu\ P)\ \frac{\pi d}{12} \ldots\ldots\ldots\ldots\ldots \text{ft-lb per rev} \quad (11)$$

Time for one revolution is $\frac{\pi\ D_{BR}}{12\ V}$ .....(min)

For each bend set, the friction energy is:

$$E_{FR} = \frac{(3\mu\ P)\ \frac{\pi d}{12}}{\frac{\pi\ D_{BR}}{12V}(33{,}000)} = \left(\frac{\mu\ P}{11{,}000}\right)\frac{d}{D_{BR}}(V)$$

hp per bend set (12)

Therefore for a two bend processing scalebreaker, total friction energy is:

$$E_{TFR} = \left(\frac{\mu\ P}{5500}\right)\frac{d}{D_{BR}}(V) \ldots\ldots\ldots\ldots\ldots \text{hp}$$

$$\text{or: } \frac{E_{TFR}}{W \times \frac{V}{100}} = \left(\frac{\mu}{55}\right)\frac{P}{W}\left(\frac{d}{D_{BR}}\right) \text{hp per in. per 100 fpm} \quad (13)$$

Elongation work and energy — Since the permanent elongation which takes place during the processing operation is small percentagewise, close approximations may be made based on Figure 12-D.

Total force during elongation =

$S_{yp\ ave} \times W \times t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$lb (14)

Distance traveled by force $= (\epsilon - 1)\ l \ldots\ldots\ldots$ft (15)

Total elongation work in a two bend operation is:

$W_{TEL} = S_{yp\ ave} \times W \times t \times (\epsilon - 1)\ l \ldots\ldots\ldots$ft-lb (16)

Therefore for a two bend processing scalebreaker, total elongation energy, with time element equal to $\frac{l}{V'}$ is:

$$E_{TEL} = \frac{S_{yp\ ave} \times W \times t \times (\epsilon - 1)\ l}{\frac{l}{V} \times 33{,}000}$$

$$= \frac{S_{yp\ ave} \times W \times t \times (\epsilon - 1)\ V}{33{,}000} \ldots\ldots\ldots \text{hp}$$

$$\text{or, } \frac{E_{TEL}}{W \times \frac{V}{100}} = \frac{S_{yp\ ave} \times t \times (\epsilon - 1)}{330} \text{hp per in. per 100 fpm} \quad (17)$$

The grand total energy in a two bend processing scalebreaker is:

E_T = bending energy + friction energy + elongation energy

or, $E_T = E_{TB}$ (eq. No. 10) + E_{TFR} (eq. No. 13) + E_{TEL} (eq. No. 17) ..... (18)

These results are on a net basis and proper efficiency allowances must be made to determine suitable input power requirements.

DISCUSSION

PRESENTED BY

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J. I. GREENBERGER, Group Engineer, United Engineering & Foundry Co., Pittsburgh, Pa.

R. D. HUFFINGTON, Superintendent Continuous Pickling Department, Gary Sheet and Tin Mill, United States Steel Corp., Gary, Ind.

DON A. McARTHUR, Chief Engineer, The Wean Engineering Co., Inc., Warren, Ohio

WARREN L. COOPER, Assistant to Superintendent, Jones & Laughlin Steel Corp., Aliquippa, Pa.

R. V. Cordingley: This fine paper incorporates ideas which will undoubtedly alter the design of new lines built in the immediate future. We are especially interested in the feature wherein the scalebreaking equipment is located immediately ahead of the pickling tanks.

With reference to Mr. Greenberger's comments regarding hot rolling practices affecting pickling rates, the results of one experiment conducted in our plant pertaining to this variable may be interesting. One item of nineteen coils was coiled on the hot strip mill at an average temperature of 1090 F. Another similar size item was coiled with an average temperature of 1232 F. Both items were from the same type of steel rolled to the same width and gage. Material rolled at the lower coiling temperature was successfully pickled at 600 fpm. The pickling line limitation prevented any higher speed which may have been possible. The material coiled at the higher temperature was pickled at a maximum speed of 500 fpm. Even at this speed some smudge was apparent. It was also observed that the loosely wound coils showed more smudge than the surfaces of coils which were coiled tightly.

There are some minor points pertaining to Mr. Greenberger's paper that we would like to question.

1. Perfectly flat strip must exist on the coil ends to obtain optimum welding practice. Is it possible that experience would dictate that leveling rolls would be required at the exit end of the No. 1 entry looping pit in order to insure flat strip on the tail ends of coils to be welded?

2. With respect to the scalebreaking rolls, is it possible to indicate the amount of tonnage rather than the length of time between grinds? Also, is any data avail-

able indicating the total roll life, type of steel rolls used and roll cost?

3. Is it necessary to use some type of intricate control to prevent the tail ends of coils from going completely through the welder when exhausting strip from the No. 1 looping pit at 1200 fpm?

4. Would there be any benefit in a second looping pit when utilizing heavier coils such as an average approximating 14,000 to 17,000 lb?

J. I. Greenberger: In answer to the questions raised by Mr. Cordingley and the Youngstown Sheet and Tube operators, I would like to point out that the speed of entry of the tail end of the coil into the No. 1 looping pit would be quite low. In other words, a 1200 fpm entry zone speed would be reduced practically to threading speeds at the time you are running the tail end of the strip into the pit, because you have reached the end of the coil and automatically do slow down.

We do not anticipate any tail end damage which will warrant leveling rolls at the end of the No. 1 looping pit. However, there are two pickle lines which have been converted to double-entry end looping pits. These pickle lines are at Richard Thomas plant in Ebbw Vale, England and the conversion is just undergoing completion. Within the next thirty days we hope to have practical answers to questions such as this.

If it is found necessary to put in some leveling means after the No. 1 looping pit it will offer no difficult mechanical problem.

In terms of roll life, four to six weeks of operation corresponds to between 20,000 to 30,000 tons of steel for the work or flexing rolls. These flexing rolls are a high carbon, high chromium, forged steel alloy. They are expensive, but are the most abrasion-resistant material we could find. After four to six weeks in operation, the grinding amounts to approximately $\frac{1}{32}$ in. to clean up the rolls. The backing rolls happen to be one of the cheapest materials and yet one of the best. It is our own special process nickel iron, and these rolls are in from five to six months; so they would be getting some 150,000 tons out of these backing rolls between grinds.

Actual operating costs I cannot give you. Those would have to be checked with people like Dominion Foundries.

The problem of losing the tail end of the coil when running at 1200 fpm is a good one, but actually present entry ends of pickle lines are running in some instances at speeds up to 2000 fpm. Most of these high-speed lines have dropped their speeds in order to minimize coil damage, but still they are running at high entry speeds, and the loss of the tail end there would seem to be the same type of control problem as was raised by Youngstown Sheet and Tube operators. I believe the question answers itself.

In answer to the fourth question, we believe the nomograph of Figure 11, which could be checked for all types and combinations of conditions, will show that some 20 to 30 to 40 per cent production increase can be predicted even on 14,000 to 17,000-lb coils. Actually, a 14,000-lb sheet gage coil weighing roughly 14 lb per foot corresponds to only 1,000 ft of strip. If you were trying to run your pickle zone at 500 fpm, that 1,000 ft of strip represents only two minutes of running time between joining operations. Checking the nomograph indicates that all cases whether short length or long length coils will show an appreciable production increase by use of the double-entry looping pit.

R. D. Huffington: This paper is the most comprehensive study of continuous pickling that I have seen. It briefly, but clearly, sets forth the variables that make scale breaking preparatory to pickling a vital concern in maintaining maximum line speed and production.

At the Gary Sheet and Tin Mill, we have four continuous pickling lines with uncoiler-breaker speeds of 1200 fpm and maximum pickling speeds of 425 fpm. Our uncoiling speed, with a single looping pit, prompts the question; is the looper pit ahead of the proposed breaker a wet or a dry pit? And if wet, does the breaker have a different action than with a dry strip? In this same connection is "balling up" or accumulation of oxide a problem in pitting the surface? If not, how is it overcome?

While it may be agreed that work hardening due to a scalebreaking operation may be of little consequence when cold reduction follows the pickling, there is sufficient production of hot rolled pickled coils to raise the question of scale—breaking this material which might be detrimental, depending on its end use and some of those variables referred to early in this paper. Specifically, what extension is expected on various typical gages in using this scalebreaker? Also what Rockwell increase can be expected with different gages? I have an additional question involving extreme pressure and extension. What is the experience regarding distortion, namely; camber, wavy edges, etc.? Is the hazard encountered on all widths or more prevalent on wide widths?

Finally, what are considered the major advantages in scalebreaking by flexing over temper rolling or shot blasting as a preparation for continuous pickling?

J. I. Greenberger: As we visualize Figure 4, we are and do contemplate using both pits wet. The scalebreaker at Dominion Foundries and Steel Co. which has been in operation for thirteen months is operated wet. In that length of time we have observed no balling up, no accumulation of oxide. It is an excellent question but apparently the problem does not exist. Incidentally, the same question was raised by another company with equally capable operators.

We have called for both pits being wet in the installation at Richard Thomas. To protect the welder in the welding and trimming zone, we precede it with an air drier or blower to remove the excess water from the surface of the strip. If the welder transformer coils and all the electrical components involved could be made so that wet operation through the welder would be of no consequence, the water remover or drier could be eliminated.

The work hardening is a very interesting question. We have run many tests and will be pleased to discuss the detailed test results with anyone, wherein we compared scalebreaking and work hardening through conventional processors, scalebreaking and work hardening through a cold rolling operation of 2.4 per cent, and scalebreaking and work hardening through our processor. We found (and the tests proved) that even the

present conventional processors, which were far behind either the mill or our scalebreaker in terms of quality of scalebreaking, showed the same degree of hardening within 1 to 2 points Rockwell as obtained either in our processor or in the cold rolling mill. We are obtaining 5 to 6 to 7 points Rockwell increase, which increase is within 1 to 2 points of that obtained on present equipment, on which equipment you are not getting the benefits of the scalebreaking.

You find that the chemistry of the steel and aging characteristics of the steel are such that once you initiate the slightest degree of strain by cold work, there will be an aging process, and about an additional 4, 5 or 6 point Rockwell rise regardless of how much cold work you do initially.

As to extension, in the two large machines that have been running one and two years respectively, actual resultant permanent extension after passing through the machine ranges between 0.5 to 1 per cent. That 0.5 to 1 per cent permanent elongation, which is measured after going through the breaker, is not to be confused at all with the scalebreaking process. The scalebreaking process is dependent on the flexure of the surface while going through the machine, and we go from +2 or +3 per cent to −2 or −3 per cent. We therefore get 4 to 6 per cent surface motion, yet when we are out of the breaker the residual permanent elongation is maybe 0.5 per cent. That is an important point, and one that has to be mulled over a bit.

We are not to confuse permanent elongation with the degree or quality of scalebreaking. They have nothing to do with each other. The permanent elongation is a mechanical phenomenon due to the fact that we have gone above the plastic range in taking a flexure first in one direction and then taking flexure going in the other direction. There is no simple relationship between the resultant permanent elongation out of the scalebreaker and the quality of scalebreaking that the scalebreaker can and does do.

As far as camber and wavy edges are concerned, in the Dominion machine and in the installation at Usinor, we specify use of tension after the machine. We ask for the drag pinch rolls. The purpose of this is to produce a good guiding means. We have observed that the scalebreaker actually flattens and improves wavy edge conditions. It improves the strip shape by virtue of the combination of tension and going above the yield point in flexure.

We have run a considerable series of tests on aluminum strip, and are studying for the aluminum industry flattening and leveling machines for just that purpose. They will have nothing to do with scalebreaking but will be flattening machines.

The last question concerned temper rolling, and also comparison with shot blasting and present typical processors. The Dominion Foundries and Steel Co. originally had a shot blast unit followed by a wet pickling bath arrangement which permitted them to run some 80 to 90 fpm. Due to various difficulties which I prefer not to discuss, but which may be discussed with the operators, that unit was replaced by a scalebreaker and a conventional pickle zone, which then permitted pickling speeds up to 400 fpm.

We have compared all types of breakers with our scalebreaker, and we can guarantee and demonstrate that our unit will do more than any existing machine today.

As far as a mill is concerned, a mill is an excellent scalebreaker, but it is doing it at 45,000 to 50,000 lb per in. of width rolling pressure. It requires an operator. The mill rolls are replaced after rolling about 3,000 to 4,000 tons because under those pressure conditions, and under the conditions of rolling oxide, the rolls are grooving. We believe the scalebreaker is the proper scalebreaking means. The use of a mill in a pickle line for flattening strip for a particular product requirement may be an excellent idea. We would suggest, however, that the mill in the pickle line be located where it does not wear itself out as it is doing at present. Put the mill after the pickle zone, where it will not have to be rolling an abrasive surface.

Don A. McArthur: Finding means of increasing the production of continuous pickle lines has occupied a great deal of our time for the past 21 or 22 years. What has been accomplished is rather dramatically illustrated by comparison of the first and the latest of our pickle lines.

Early in 1935 we received a serious complaint regarding one of our pickle lines. The complaint was that it would not run slower than 40 fpm, and they just could not pickle that fast. Our latest pickle line, with a minor increase in acid tank length, is being geared for 1000 fpm, and the operators confidently expect to reach that speed.

Mr. Greenberger mentioned several of the ways that this has been accomplished, including increasing length of acid bath, which is minor; increasing temperatures; concentration and agitation of the acid, which is major and necessitated very major revisions to acid tank design; improvement in scale condition and coil length on the hot rolled strip, which we must admit is probably the most predominant of all reasons; and improvement in mechanical working of the strip surface. We should also mention improved techniques of operation and rearrangement of equipment to save a few seconds here and there, for while it is easy to keep a line operating at 40 fpm almost continuously, it becomes very very difficult to keep a line operating continuously at 1000 fpm, or even 500 fpm.

As to mechanical flexing, the first—and we feel the best machine—built for this purpose is our processing uncoiler. The first one was installed in a continuous pickle line in 1930, and since that time between 130 and 140 have been installed on continuous pickle lines and hot rolled shear lines. It is a triple purpose machine. First, it is the most efficient uncoiler developed to date, and saves many seconds in getting a new coil started into the line; second, it processes the strip before objectionable random cross breaks can occur, and prevents such cross breaks from occurring by subsequent rough handling such as piling in a looping pit; this is very important for cold reduced sheet products; third, it cold works the steel to break scale, but differs from the machine described in this paper, in that it uses tension to keep the strip bent around the flexing rolls.

Realizing the need for much greater flexing and high-

er speeds than had been previously used, eight or nine years ago some radical improvements were made in our standard processor. These included an additional processing roll and an expanding mandrel. Between 25 and 30 of these improved machines have been installed or are under construction. Speeds of 2000 fpm are being used every day with entire success, and this speed is essential if speeds over 500 fpm are to be obtained in the processing section of the pickle line.

Lines with these machines in them are achieving some spectacular high tonnages and low immersion times, but we must emphasize again that this is not due entirely to any one cause—*all* of the items mentioned play their part. One hundred tons an hour are common as a monthly average on a dozen or more pickle lines. Over two hundred tons per hour has been reached for an average of an 8-hour run. Over 125 tons per hour has been averaged for a complete month. These figures correspond to immersion times of 20 to 30 seconds.

In connection with surface working, we must mention that in one pickle line we have installed a 2-high roller bearing temper mill in addition to the double breaker roll expanding mandrel processor. By using an elongation of approximately two to four per cent, additional scale is loosened and higher speeds are possible through the tank section of the line. In choosing this equipment the operators considered the following features: it is a very conventional piece of equipment, easy to operate, well known in the industry, and certainly capable of the high speeds necessary for a high production line. It was considered that it would loosen scale at least as well as any other machine, and probably better—and it seems to have proved this in actual operation. It is also used to some extent to correct shape of the hot rolled strip before it enters the cold mill.

I might comment very briefly indeed upon the double loop idea presented by Mr. Greenberger. This has been discussed many times in past years, and although certainly some saving in time can be made at the entry end of a line, we have never found anyone willing to spend the rather considerable sum of money necessary to install it in a very high speed entry end. When time from the tail end of one coil to the completion of a weld and trim is cut down to about one minute and thirty seconds, as is being done in many single looping pit lines, the advantage obtained by the two looping pits becomes much smaller. Another consideration is the fact that both old and new mills are planning on much longer coils from their hot strip mills, and with longer coils, high uncoiling speed is a much greater factor than cutting off a few seconds from the entry end operation.

We agree entirely that our patented exit looping pit is a desirable feature for any pickle line. It may be of interest that pits deep enough for an 80-ft free hanging loop are being built.

J. I. Greenberger: Speeds of 1000 fpm in a pickle line were mentioned. We have checked the Fairless production several times. Actual productions corresponded to pickle zone speeds of 310 to 350 fpm or thereabouts. It would not matter if pickle zone speed were 2000 fpm, production is still a function of that 350 fpm.

The low immersion times of 20 to 30 seconds obtained on the Fairless line are obtained by virtue of use of a mill as a scalebreaker, which takes a 2 to 2.5 per cent reduction. In the tests run jointly with the corporation many years ago, we compared the latest typical two bend processor, the 2-high mill, and our scalebreaker. Checking of the previous tests or actual tests on existing units, will show you do require either the mill or a scalebreaker to give you 20 to 30-second pickling times.

The question of the mill operation being satisfactory as a scalebreaker I question, only to the extent that as a scalebreaker it requires an operator at some $35 per turn. Our scalebreaker does the same scalebreaking job at no cost for the operator per turn. In terms of shape correction, our scalebreaker will not correct shape; in any application which can justify the use of a mill in a pickle line for shape correction, you must have a mill.

The double-entry looping pit, if you check the nomograph of Figure 11, will demonstrate that there is no condition you can assume wherein you cannot predict some 20 to 40 per cent production increase. That applies to any pickle line in operation today or any conceived pickle line.

One question raised was the fact that older mills are going to longer coils. We are not quite certain we understand just what is meant here. The mill spacing and the furnaces and the millions of dollars involved in converting a hot mill to longer coils would not seem to be comparable with what is involved in just converting picklers, or even the use of separate welding and coil build-up lines.

Warren L. Cooper: The tin plate department of Jones & Laughlin has been interested for some time in justifying, and adding, an additional scalebreaker in the existing equipment. The present scalebreaker is prior to welding and there is no way to completely break scale on the coil ends. Acid concentrations must be carried at higher levels than would be necessary were the present equipment placed on the discharge side of the welder.

We have observed one of the installations referred to by Mr. Greenberger and were favorably impressed with the quality of the work being done.

While we would not be willing to debate the engineering soundness of what has developed to be an entering speed of 2000 fpm as against the double looping pit idea presented, however, it should be pointed out that by controlling the winding of the coils off the hot mill and also the drag generator loads at the pickle line pay off reel, scratching has been reduced to the point where this stigma does not apply to the higher speeds. In fact, there have also been a minimum of maintenance problems with the 2000-fpm processor, but one producing the same tonnage at one-quarter or one-fifth the speed should naturally require less maintenance.

For those who might have occasion to question the formulae in connection with the advantages of the double looping pit, it must be remembered, as pointed out in the paper, that the results shown apply only to the conditions studied. When applied to the conditions at J. & L., it was felt that resulting estimates were very conservative.

The Purchasing Story . . . . *purchasing is a service department whose mission is to purchase such goods and services as may be required, at the lowest over-all price, and have them delivered in the proper quantity and at the time and places desired . . . . final awards are made after consideration of a number of factors which include price, quality, service, trade relations, etc. . . . .*

THIS BUSINESS OF SPENDING

By J. G. HEPLER
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▲ THE percentage of the sales dollar expended for purchased goods and services varies with individual industries and, also, with companies within a given industry. In most instances, the amount so spent is comparable to the amount paid out in salaries and wages. Everybody is conscious of the payroll; we have our unions and our industrial relations departments, who devote most of their attention to it; labor negotitaions and strikes and their effect on public opinion quite often stem from payroll expenditures. Of equal impact on the financial structure of a company, are those expenditures for outside goods and services. All levels of management are fast coming to the realization that such spending must be controlled by personnel who are specialists in their field; whose business it is to buy in such manner that the company's ultimate interests are best served, if the company is to prosper.

Purchasing can be regarded as a service department and we, who are in purchasing, must be sure that in performing the service, we accomplish a mission. That mission is to purchase such goods and services as may be required, at the lowest ultimate price, and have them delivered in the proper quantity and at a time and place which meets our requirements. My first job in the Navy was communications duty. I did not like it much because it seemed to be removed from the direct line of activity. My skipper used to boost my morale by telling me that good Naval Communications would never win a war, but the lack of them could lose one. I believe that thought is equally applicable to purchasing and the financial health of a company. Good purchasing will never, in itself, assure the success of a business, but poor purchasing can be a heavy contributor to financial difficulty and bankruptcy.

Good purchasing is not accomplished by any different means than that required for good engineering or good operating. You must start with a foundation of highly trained and experienced personnel who thoroughly understand the work if you are to attain success. The quality of purchasing is also dependent largely on the training, experience, and skill of the people and the organization of the department. Good purchasing considers price as only one factor in a transaction. Quality, delivery, service, trade relations, and, at times, public relations, union agreements, and many other factors must be weighed before a proper decision can be reached. We work closely with engineers and operators. We respect the knowledge and experience each of these have in their work and, in turn, we hope that they realize that ours also is a specialized work requiring skills different, perhaps, but nonetheless, equally important to the financial well being of our companies.

Looking backward, a long way down the road, we know that buying was done in a haphazard manner. A foreman or supervisor stated something was needed; somewhere along the line it was approved, and someone in the city office obtained three bids, took the lowest, and something was bought. Three was a good figure; it was sufficient to claim competitive coverage and it did not require much hustling to get quotations.

We do not work that way anymore. I, personally, feel that, in some instances, a good buy can be made with no competition and, on the other hand, in many instances competitive bidding by numerous suppliers is a must. Purchasing repair and maintenance items, off the shelf supplies, catalog material, call it what you may, does not require competitive bidding on each order. Jobbers, distributors, and sales representatives

can easily apprise you of their inventory position, price schedules, and service facilities. This will permit you to place orders in line with price, service quantity, and quality requirements. Thereafter, you can test the market periodically to develop new sources of supply or get competitive bids where a purchase of significant quantity is involved. Other than that, competitive bids are not required. Many commodities lend themselves to forecasting estimated requirements for a specified period of time. Where such forecasting is possible, we like to get competitive bidding for an estimated quarterly requirement, designate the successful bidder, and issue an order which permits releases by plant storekeepers to meet their needs. Copies of the release come to the buyer issuing the order for review of quantities being ordered. We are controlling the purchasing function by designating the source of supply, eliminating a lot of time-consuming and costly paper work, improving the service, and, finally, we are getting a better price because we have reduced the vendor's costs.

Let us briefly discuss the purchasing involving expenditures for the acquisition of machinery, building, and equipment which are to be capitalized on the company's books. These are the purchases which require the cooperation of many departments, operating, engineering, and purchasing, if the company's interests are to be best served. The money for such purchases comes from income which remains after taxes, interest, and dividends have been paid. They stem from depreciation provisions or from loans or equity financing. These expenditures *must* be sound, because they have a profound effect on the long-term financial structure of your company.

In the preliminary stages, you will require cost estimates for budgetary purposes. Such estimates usually require preliminary pricing. I believe a representative price can be obtained from one supplier—two, at the most. The suppliers selected should be advised that the information is for pricing purposes only; a detailed preparation of a bid, which can be costly in many instances, is not required at this time. When it has been decided to proceed with the project, clear, complete, explicit specifications should be prepared. They must be flexible enough to permit competitive bidding on the part of several responsible bidders.

We recognize that operating and engineering have an interest in the equipment being bought. We want their opinions as to which is or is not acceptable from the operating or engineering viewpoint. After receiving their viewpoints, it is our job to award the order after due consideration of *all* the factors which must be considered in making an award—price, quality, service, trade relations, and others.

There is one hard and fast rule that we have in sending out inquiries. "*Do not ask a firm to bid if you do not intend to give them consideration at the time of an award.*" Your purchasing department should have records of bidders who are interested in various types of projects. The records should indicate the financial responsibility, performance record, and capabilities of the supplier or bidder. New bidders should be carefully checked to establish their performance records with other concerns or industries.

When the inquiry list is complete, establish a due date for quotations and forward identical data to all bidders. If certain matters in the specifications require plant visitations for consultation with engineering, give all bidders equal opportunity. I need not mention that it is engineering's job to see that all bidders receive identical information. Specifications should never be modified verbally. If a change is necessary, prepare an addendum for distribution to all. Insist on a bid in accordance with specifications. If a novel idea is proposed, we welcome it, but as an alternate to the specification, not as a substitution for it. Hold alternate bids in confidence and do not solicit competitive bids on a proposed alternate. We do not believe in having others profit from the ingenuity of some. If a due date is extended for one, extend it for all.

We like to have a final negotiation of price. It gives all bidders an opportunity to correct errors and to adjust prices just prior to an award. When the award has been made, the unsuccessful bidders should be notified promptly. We do not divulge price information, but I, personally, believe the unsuccessful bidder should be advised if price, delivery, utility, or other factors prevented favorable consideration of his proposal. The salesman has a boss who expects him to find out the reason for losing a job; it seems only fair to let him know whether his price or delivery was out of line with competition—perhaps by doing so—and, again, I want to emphasize this—without divulging actual price information, we will get a better proposition on the next inquiry.

Purchasing people differ in their approach to procurement problems. I do not intend to be sacrilegious when I say that my office is equipped with a desk, not a pulpit. My job is to buy in such a manner that my company's best interests are served. This can be done while adhering to those principles which have been established for guidance by the National Association of Purchasing Agents. Boiled down, it can be covered by saying that we treat suppliers as we want our company to be treated by those to whom we are bidding. We treat salesmen as we would want to be treated if we were sitting on the other side of the desk. We are going to have an occasional battle over delivery or intent at time of purchase, or some unforeseen contingency, but there has been no problem yet, which could not be resolved by responsible adults acting in behalf of reputable business organizations.

In addition to our primary procurement function, there are many ways in which our time can be profitably employed. We must constantly revise and improve our practices and procedures. We must train buyers who can think, analyze, and recognize the pros and cons of commercial problems. They must be able to work cooperatively with men of other departments. They must be receptive to proper counsel. We must be alert to changing market conditions. Inventories must be watched. Our production costs can be seriously inflated if we are caught with heavy inventories during a period of falling prices, or if we are caught with inadequate inventories during periods of rising prices. We must see that all levels of management are aware of lead times necessary to procure materials. We must establish ways and means to try materials in such manner that precludes duplication of effort. We must see

that the people who call on us are given courteous treatment and the opportunity to present their story to those who are best qualified to judge its merits.

There are many, *many* ways in which a purchasing department can prove its worth and make the team. If we fail, then we must blame ourselves because there can be no doubt about the opportunities being present.

THE PURCHASING—SALES RELATIONSHIP

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▲ THE previous paper, "This Business of Spending," has discussed purchasing's job as it relates to its principal concepts. This discussion will be primarily directed at the purchasing sales relationship.

What does purchasing expect from salesmen?

It has been said that the only difference between a salesman and a buyer is about 2½ ft—or the width of a desk. In other words, when we speak of a purchase, we are, at the same time, speaking of a sale—a single transaction consummated only when both buyer and salesman are in complete accord. Let us remember that —each one of us is working toward one end: a profit for our respective employers. To achieve this end, a purchase order must be both a good buy and a good sale, which necessitates complete cooperation between seller and buyer.

What, then, does purchasing expect of the salesman who calls on us? We would like to approach that subject by taking a close look at the lost order report—most salesmen are in some degree familiar with that. In a recent national survey, some rather startling figures were published concerning lost orders.

Of 100 lost orders, 68 were lost due to indifference on the part of the salesman, 14 because of unresolved complaints, 9 on account of price, 5 because of personality differences, 3 due to location, and 1 because the seller went out of business prior to the placement of the order. Let us analyze those statistics:

I. Some 68 per cent of orders lost is due to indifference on the part of the salesman. Perhaps indifference is an unhappy choice of words. We would prefer to interpret that as meaning the lack of complete knowledge of the seller's own product or the buyer's requirements. The salesman must prepare himself with a lot of information regarding the prospective buyer's requirements before he can hope to make a sale. He must know or learn that in selling equipment to—for instance—the steel industry, equipment designed for rugged service is required. Unless this missionary work is accomplished, the salesman will just waste time.

In that same connection, and upon learning the requirements of the purchaser, the seller must demonstrate why his product is better for a particular need. It is imperative to indicate to the buyer improvements in quality, reduction in ultimate costs, betterment of service. Only then can the salesman whom purchasing receives hope to correct a situation where 68 per cent of business is lost due to indifference.

II. Some 14 per cent of orders lost is due to unresolved complaints. This is directly attributed to a lack of thoroughness or follow-through. The seller who receives orders and continually misses shipping promises will lose business. Those who fail repeatedly to quote promptly or even acknowledge receipt of an inquiry, will fail to receive orders. Those who repeatedly engineer features into machinery or equipment that are incompatible with operating requirements, will not get orders. Lack of assistance on backing up warranty provisions, correcting erroneous shipments or resolving claims, will only result in a poor order book.

Purchasing must count heavily on the salesman and the company he represents. If the salesman has the ability to follow through and do a thorough selling job, 14 per cent of the orders will not appear on lost order reports.

III. Some 9 per cent of orders lost is due to price. It will come as no surprise to anyone that purchasing is interested in price. It is a surprise to some that we are not interested in price alone. Today, we prefer to refer to ultimate cost or, in other words, consider price in conjunction with quality for intended use, service, dependability and delivery. No purchasing departments today like to be referred to as price buyers. However, it is the salesman's responsibility to prove the merits of his offer—to prove the value of his product.

Let us consider price as being based on three concepts:

1. Price must be considered as cost plus a fair profit. We know of no business that can exist without making a profit.
2. We have little or no control, as buyers or salesmen, over the factors that constitute price.
3. Price is determined by competition.

The salesman should be in a position to discuss price of his own product including what factors constitute price. He must be able to defend his price as competitive. Purchasing will not pay premium prices, but a buyer will pay price differential to those sellers who demonstrate a lower ultimate cost to the user.

IV. Some 5 per cent of orders lost was due to personality differences. Frankly, that figure seems high and if we are to interpret it in its strict sense, we can only assume that the onus lies equally between seller and buyer. It is a poor commentary on today's business to admit that such differences stand in the way of sound relationship and good business practice. But let us recognize that they exist and lay down some qualifications for the buyer and the salesman. We would list them thus:

1. Honesty and integrity.
2. Pleasant personality.
3. Poise.

4. Ability to "get along" with others.
5. Sound commercial sense.

V. Some 3 per cent of orders lost were due to location. This is entirely plausible, since a part of the transaction that comprises the purchase and sale is service. It is generally reasonable to assume that the best service can be rendered from a location close to the point of use. However, no purchasing department which adopts the practice of what may be called local purchasing, will hold an umbrella over the supplier. We must remember that service is only one factor in evaluation of cost.

VI. One per cent of orders lost is due to business failure. No further comment is necessary—that has an air of finality.

That is the story of 100 lost orders. It may be well to review lost order reports for October, with one thought in mind—why. An analysis of these reports could indicate what is necessary to improve the sales picture.

Thousands of salesmen are knocking at our doors every day and we, in purchasing, welcome you. Although we have no national statistics, about 1200 call on U. S. Steel in Pittsburgh, every week. We recognize that it is through the salesman that the buyer can equip himself to do a better buying job for his company. If you assist the buyer in his job by giving a thorough, concise report on your product and its relationship to our requirements, the profit picture on all the annual reports is going to be a good bit better.

Remember that we too read the papers and know all the football scores. We heard the one about the dog who drank martinis every night and we realize that everyone has trouble with his mother-in-law. What we want to know is what you are selling and we would like to hear about it. We, to do a better job, need to know what you have to offer.

Knowing, then, what you have to offer, we, in purchasing, are ready to buy. It is axiomatic that one order can be awarded to only one supplier—the one who does the best over-all job of selling. All others will fail. Did you ever consider, however, what a great privilege exists in America—the privilege to fail? In many areas of the world today that privilege does not exist, for, to have the privilege of failure, you must have the opportunity to succeed. Lose that prerogative for failure—that opportunity for success—and you lose the American competitive system.

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RECTIFIER EQUIPMENT SUPPLIES D-C POWER IN STEEL PLANTS

By C. S. HAGUE

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▲ THE steel industry is one of the largest users of d-c power in this country. The adjustable speed characteristic of the d-c motor enabled the electric drive to supplant the steam drive at the turn of the century. Since that time the use of d-c power has steadily grown in the industry—not only for main and auxiliary driving motors, but also for electrolytic tinning and cleaning lines. Of the 35,000,000,000 kwhr of electrical energy consumed annually by the industry, it is estimated that over half or approximately 20,000,000,000 kwhr is in the form of direct current.

Until approximately 20 years ago, the motor-generator set was used to supply this large block of d-c power. In recent years, however, static rectifiers have found increasingly frequent use in the making of steel and today are being purchased almost exclusively for at least one class of application i.e., 250-volt supply for auxiliary motors.

It is the purpose of this paper to present the major types of rectifiers now being applied in steel mill service and to review their salient characteristics. These rectifiers are used for three principal types of application:

1. 250-volt constant potential supply for auxiliary drive motors.
2. 700-volt supply for main drive motors.
3. 6 to 36-volt supply for tinning lines and cleaning lines.

The mercury arc rectifier is used for (1) and (2). Metallic rectifiers have been used for several years for (3): recently, however, the semi-conductor rectifier has become commercially available and is now ready to compete with selenium and/or copper oxide for this low voltage field.

Several papers have previously been presented on rectifier equipment, to the AISE and to other technical groups, that have discussed many of the characteristics that will be touched upon herein. In spite of this publicity, however, there are still many who are not familiar with the characteristics of rectifiers and their relative advantages and disadvantages as compared with rotating machines. Hence, it is timely to again consider the application of rectifiers to the making of steel.

250-VOLT CONSTANT POTENTIAL SUPPLY

In terms of installed capacity, the 250-volt auxiliary supply is by far the most important application of rectifiers in steel mill service. Over 350,000 kw are now installed or on order. Prior to 1937 this field of application was monopolized by motor-generator sets. At that time the single anode synchronously excited type rectifier became available and began to supply this type load. Its use has since steadily grown until today it is usually the only type of new conversion equipment considered in ratings from 300 kw to 3000 kw.

For what reasons did the mercury arc rectifier take over this field? Although several could be mentioned, there are three important ones—higher efficiency, reduced maintenance, and lower installation costs.

For a 1000-kw, 250-volt rating the average losses of a rectifier will be approximately 33 kw less throughout the load range than those for a motor-generator set. This difference in losses varies only slightly throughout the load range since the greater difference in efficiency at light loads, resulting from the relatively high friction and windage losses on the rotating machine, compensates for the reduced base killowatts at lighter loads. At a power rate of 1¢ per kwhr this difference in losses results in an annual power bill saving of approximately $2000 in favor of the rectifier, based on 6000 hours operation.

Maintenance on a rectifier is appreciably less than that of a motor-generator set. Commutator dressing, brush replacement, winding blow-out and re-varnishing, and bearing maintenance are all major items that

Figure 1 — Typical open type rectifier installation shown has units rated 1000 kw.

Germanium rectifiers warrant serious consideration for low voltage, high current d-c power application . . . . factors are high efficiency and, since there are no moving parts, long life and low maintenance . . . . for higher voltage application, mercury arc rectifiers have many advantages over the motor-generator set, particularly for non-reversing mills such as hot strip, rod, and merchant mills.

are eliminated with the static rectifier. Maintenance costs for the rectifier are reported from various users of both types of equipment to be from one-third to two-third that of a motor-generator set. Another facet of this reduced maintenance is reliability and availability for service. Surveys of users of rectifiers show them to be available for service 99.6 per cent of the time; thus eliminating in some instances the amount of spare capacity to be purchased.

Perhaps the most important advantage of the rectifier in the 250-volt class is its reduced installation costs. The need for special foundations to withstand shock and vibration is eliminated. A reasonably level floor of sufficient strength to support the static weight is all that is required. Alinement costs are eliminated. Rigging cost is reduced by the ratio of relative weights.

Experience indicates that the installation cost for the motor-generator set is approximately 35 per cent of the equipment selling price. For the rectifier, installation cost is only approximately 10 to 15 per cent of equipment selling price. Thus the installed cost for a rectifier is usually less than that for a motor-generator set even though the selling price of the rectifier *at this voltage rating* is somewhat above that for the motor-generator set.

Recent trends in rectifier assembly practices will further lower the installation costs. Figure 1 shows a rectifier installation typical of most of those now in service. The rectifier tubes with vacuum pumping accessories are mounted on one frame. The excitation equipment is mounted in a cubicle. The heat exchanger is on a separate frame. A-c and d-c switchgear are visible at the end of the room and the transformer is located outside the building. The rail fence keeps unauthorized personnel from touching the rectifier frame which is at positive bus potential.

The units shown in Figure 1 are rated 1000 kw. The majority of rectifier units in steel mills carry a rating at least equal to this. However, there has been available for about 15 years in ratings at 500 kw and below a metal enclosed, unit substation type construction using sealed tubes. Figure 2 shows such a unit. Reading from left to right the cubicles house auxiliary compartment, a-c breaker, dry type transformer, rectifier and d-c breaker. The advantages of this packaged type construction from the point of view of space saving, better appearance, greater safety, and reduced installation costs are obvious. For this type rectifier, the tubes do not have a vacuum pumping system and, therefore, require eventual reconditioning or replacement when their internal vacuum becomes impaired as a result of

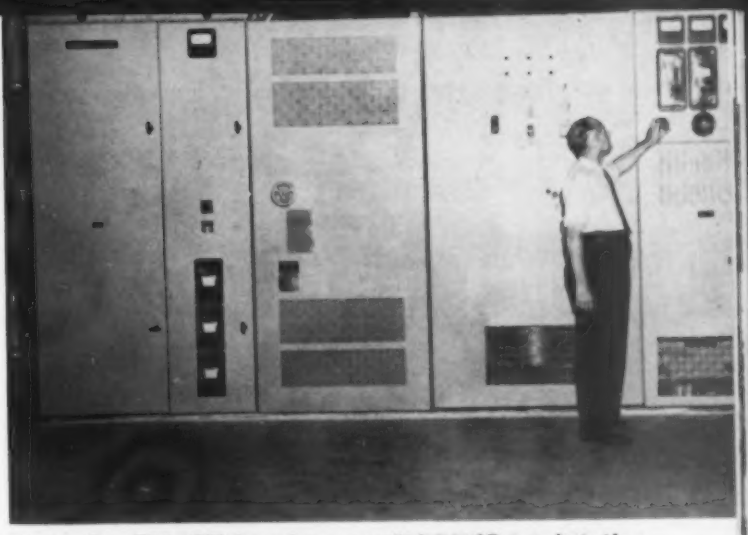


Figure 2 — This 500-kw close coupled rectifier substation uses sealed tubes.

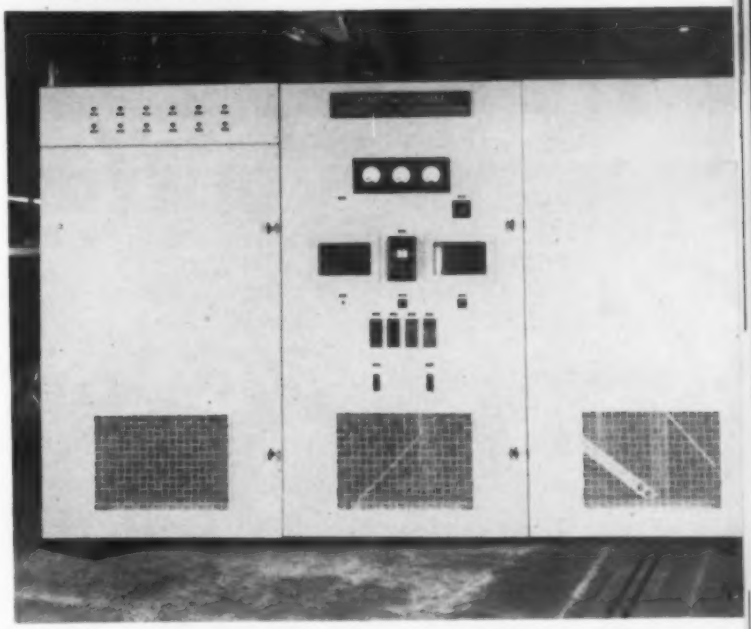
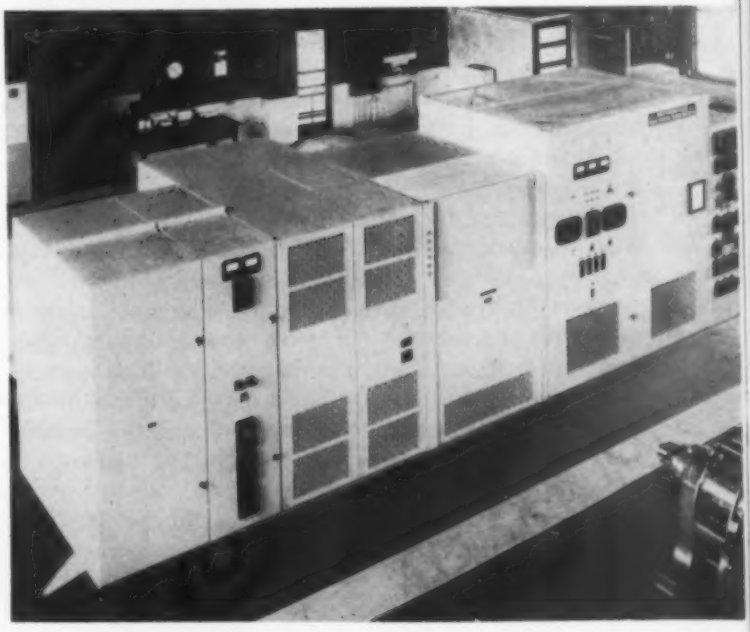


Figure 3 — New cubicle type construction for rectifier tubes, vacuum system, excitation system, and water cooling system.

Figure 4 — Typical 1000-kw installation utilizes metal enclosed pumped tubes.



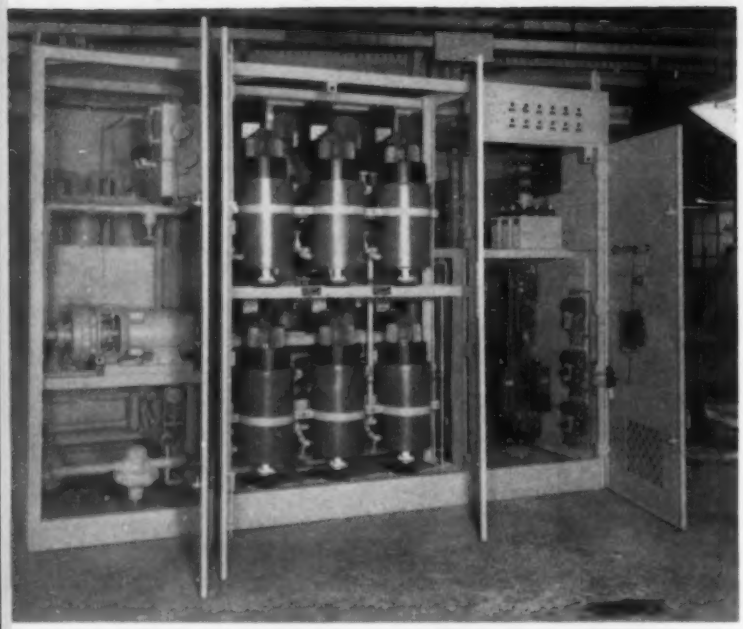


Figure 5 — Rectifier cubicle has large sealed tubes.

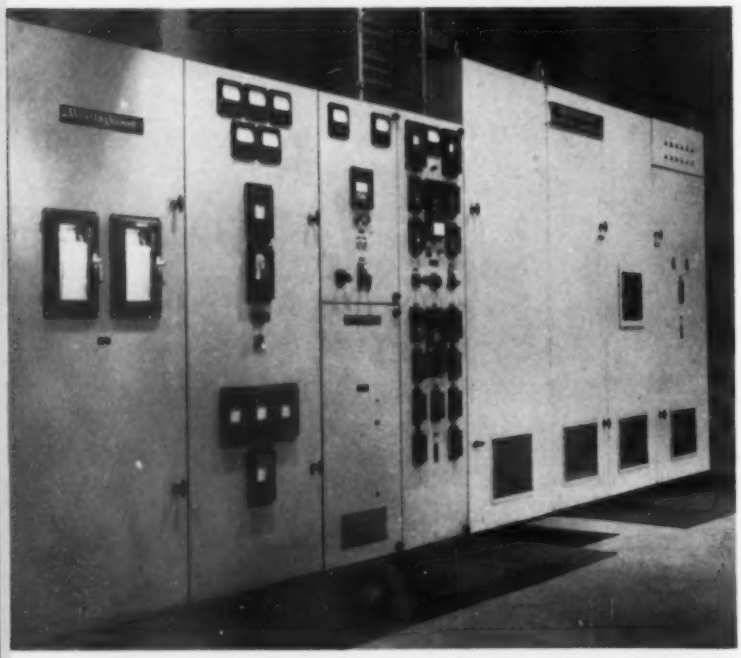


Figure 6 — Typical 1500-kw installation with sealed tubes.

leakage from the outside and emission of occluded gases from internal parts.

To combine the ruggedness, proven ability to withstand heavy loads, and greater long time economy of the continuously evacuated rectifiers with the advantages of packaged type construction, a demand has recently developed for a metal enclosed pumped type rectifier. Figure 3 shows such a rectifier cubicle complete with the rectifier tubes, excitation circuits, vacuum pumping equipment and water cooling system. This cubicle can be located in a close coupled line-up with the a-c switchgear transformer and d-c switchgear as shown in Figure 4 illustrating a 1000-kw installation.

Since this construction became available in 1953, there have been only a few instances where an industrial user preferred the older open type construction. There are now installed and on order over 175,000 kw of metal enclosed continuously evacuated mercury arc rectifiers. Over 25,000 kw of this total are for steel mill service. It is available in unit ratings as high as 12,000 amperes.

Although the excitation circuits, the cooling system, and the switchgear equipment associated with a rectifier unit each requires more maintenance than the vacuum pumping system, some users are anxious to gain the simplification that elimination of the vacuum pumps afford. To meet this demand, larger sealed type rectifier tubes have been developed over the last few years and this type construction is also available in ratings up to 12,000 amperes. These larger sealed tubes are so designed that they can be reconditioned after becoming inoperative due to loss of vacuum. Figure 5 shows a self contained rectifier cubicle with sealed tubes, excitation circuits and water cooling system. Figure 6 shows a typical 1500-kw installation.

700-VOLT SUPPLY FOR MAIN DRIVE MOTORS

Although the mercury arc rectifier was limited in its early years to constant voltage application, experience soon indicated its ability to operate at reduced voltages by means of phase delay. This enabled it to be used as a power supply for main drive motors. The first installation in this country was on a 3000-kw, hot strip mill in 1942. Today approximately 125,000 kw are installed in this country for main drive power supply in steel mills.

The economic factors favoring the use of rectifiers at 700 volts are more compelling than they are for their use at 250. Of most importance, the sales price of the rectifier in dollars per kw is but little more than half the figure for 250 volts. The price of motor-generator sets is not proportionately reduced at the higher voltage. Hence for this voltage rating the first cost of the complete power supply equipment including the necessary cooling facilities is normally less for a rectifier supply than it is for a motor-generator set supply. This difference in price will vary from a few per cent to as much as 15 per cent depending upon the individual circumstances.

The efficiency advantage is much more prounounced. Figure 7 illustrates this. For a 10,000-kw, 700-volt installation energized 6000 hours per year with a power rate of only 1¢ per kwhr the annual savings in power bill will be approximately $30,000. The installation and maintenance advantages prevail for the 700-volt application to as great a degree as they do for 250 volts. Furthermore, the higher availability for service rating of the rectifier is of particular significance for mills with well filled rolling schedules.

These potent economic factors in favor of the rectifier are offset to some extent by some of its operating characteristics which are not the equal of those of the motor-generator set.

The power factor of a rectifier unit with no phase delay is approximately 93 to 94 per cent lagging. Voltage regulation requirements necessitate a certain amount of phase control under normal operating conditions to enable the regulator to maintain d-c voltage when other factors tend to depress it. In a practical case, the average power factor will probably be no

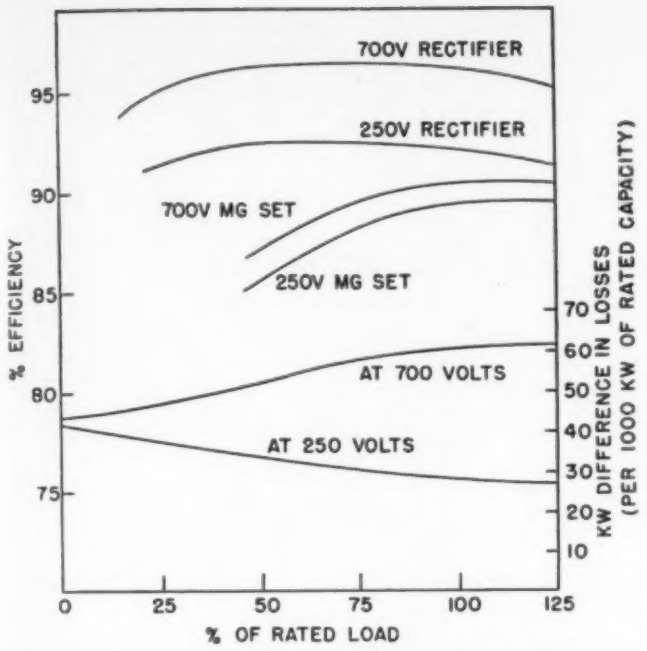


Figure 7 — Comparative efficiencies are given for rectifiers and motor-generator sets at 250 and 700 volts.

better than 90 per cent. This may or may not involve a power bill penalty depending upon the utility rate structure and/or other plant loads. Where a penalty does occur the use of power factor correcting capacitors may prove economical.

The inherent output voltage from a rectifier is determined by the turns ratio of the rectifier transformer and the impressed a-c voltage. Operating voltage can be reduced from the inherent voltage by means of phase control but nothing can be done to raise it above this value. Furthermore, reduction in output voltage below the inherent value by phase control is accompanied by approximately one per cent reduction in power factor for each per cent reduction in d-c voltage.

Hence it is important that operating schedules for the mill be as accurately determined as possible at the time the rectifier transformer is designed so that taps are provided on the transformer for all desired bus voltage. Once the range of operating voltages is determined, it must be decided whether to accommodate it by a motor operated no load tapchanger or by an under load tapchanging mechanism. Rolling schedules usually determine this choice. If a short interval is available when rolling schedules change to operate the a-c breaker and energize the motor operated tapchanger, the no load taps are quite satisfactory and should be specified. If this interval is not available an underload tapchanging mechanism—a relatively expensive device costing of the order of $25,000 per unit is used.

For a main drive supply it is important that the d-c voltage be closely regulated. Since the inherent d-c voltage from a rectifier is directly proportional to the a-c voltage, provisions must be made to prevent any temporary dips in the a-c system from being reflected on the d-c bus. Consequently, the rectifier transformer secondary windings must be designed for above rated voltage in order that rated voltage will be available for sub-normal a-c voltage conditions. Although any amount of compensation can theoretically be provided in the transformer, it has not usually been found desirable to compensate for more than 5 per cent subnormal variation in a-c voltage.

It is the fundamental principle of a rectifier that it convert a-c energy to d-c energy. It will not permit a reversal of this energy transfer. Hence it cannot absorb power from regenerating motors. Where motor speeds may be reduced by increasing field flux, a regenerative power absorbing resistor is usually provided. A common rating for this resistor is 6 to 10 per cent of rated bus capacity. The resistor is automatically controlled so that it does not dissipate energy under normal operating conditions.

Although these inherent operating characteristics must be recognized when applying rectifiers for main drive service, measures are available to satisfactorily compensate for each of them as has been proven by the several installations now in successful operation. The degree to which some of these characteristics of the rectifier offset its economic advantages is determined by many factors, such as speed cone requirements, mill operating procedures, power factor penalty clauses, stability of a-c system, other mill loads, etc., any or all of which may vary for a particular installation. In recent years, however, it has usually been found that the advantages of the rectifier outweigh its disadvantages as the main drive power supply for hot strip mills, rod mills and merchant mills.

The one-way characteristic of a rectifier is a severe deterent to its use on reversing mills or mills that frequently decelerate. Some European mills are using rectifiers for reversing mills by using two groups of tubes —one connected as a rectifier to transmit a-c to d-c and the other as an inverter to transmit d-c to a-c. However, economic factors in this country are such that it is presently very difficult for the rectifier to compete with the motor-generator set for such application here.

LOW VOLTAGE SUPPLY FOR CLEANING AND TINNING LINES

The steel industry requires d-c power in voltages ranging from 6 to 36 for electrolytic deposition processes and for cleaning processes. Requirements may be as high as 240,000 amperes for a plating supply, while a typical rating for a cleaning line will be 10,000 amperes. Over the past decade, rectifiers to fulfill this requirement have been of the copper oxide or selenium type; generally referred to as metallic rectifiers.

These metallic rectifiers, being static apparatus, have the advantage of quiet, vibrationless operation and are simple and inexpensive to install. Space requirements are small and unattended operation normally exists. Routine maintenance is very low. Their efficiency is approximately 70 to 80 per cent when new. However, during the life of the elements, the forward resistance increases causing a lowering of efficiency and often requiring several taps on the rectifier transformer to obtain rated output voltage as the units "age." Average life of the rectifying devices has been of the order of five years.

Even though the characteristics of the metallic rectifiers are far from ideal, their use in steelmaking has

Figure 8 — This 200-ampere, 32-volt germanium diode is small in physical size.

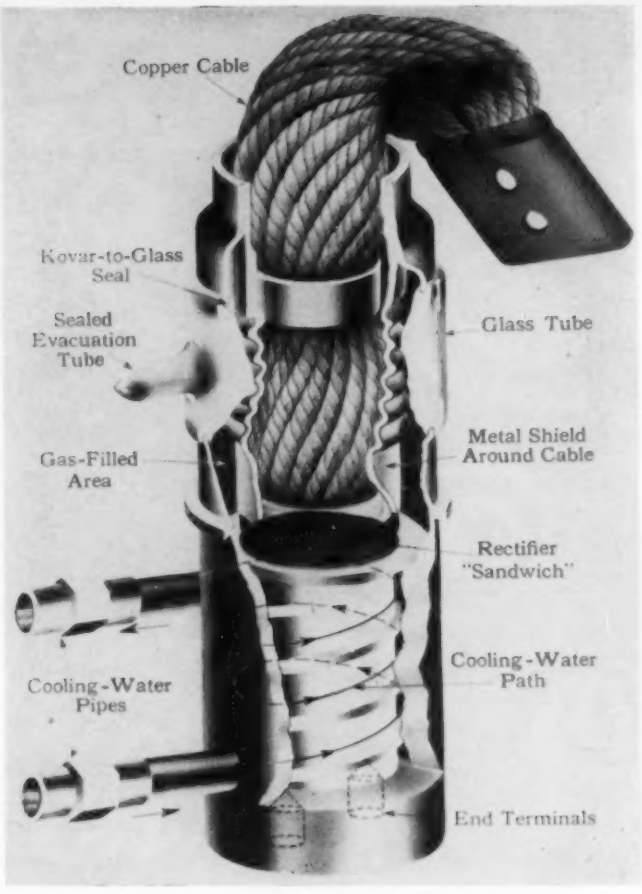


Figure 9 — Cutaway view of encapsulated diode.

steadily increased at the expense of rotating machines which initially held a monopoly on this field. Low routine maintenance, low light load losses and inexpensive installation costs were the major contributing factors. However, the metallic rectifier does not completely fulfill the need for reliable, highly efficient, long life, static conversion equipment. The semi-conductor rectifier has recently become commercially available in power ratings, and goes a long way towards fulfilling these ideal requirements. Since this is a relatively new device it will be of interest to examine in some detail its construction and characteristics.

Semi-conductor rectifiers in power sizes now in service are of the germanium type. As the first step in the construction, germanium with a purity of one part in one million must be refined from germanium dioxide. This requires a reducing process with closely controlled temperature and atmospheres followed by a refining process, where the germanium billet is passed through several heating and cooling cycles to concentrate the impurities at the trailing end of the billet which can be sheared off removing practically all impurities. Subsequently, the germanium is remelted and antimony introduced. Reforming under closely controlled conditions to obtain single crystalline structure is the next step in the process. The crystal is then sliced into thin discs and polished. Indium foil is placed on one side of the germanium and the impregnated disk placed between two layers of molybdenum. The layers of the "sandwich" are finally joined in a controlled atmosphere under pressure at high temperatures to form the rectifying diode.

The germanium is impregnated with antimony and indium to obtain rectifying action. The atomic structure of the germanium-antimony alloy has un-bonded or "free" electrons and is said to be an "N" type material. On the other hand, the layer of the material which is impregnated by the indium does not have sufficient electrons to complete the bonded structure between atoms and is said to be a "P" type material. The resistance that the junction of a "P" and "N" type material offers to the flow of current is decidedly different depending upon the direction of current. The ratio of this resistance for current flow from N to P is several hundred thousand times as great as it is from P to N. When alternating current potential is impressed on such a junction, the practical result is a rectifier which permits current to flow during the positive portion of the cycle but effectively blocks it during the negative portion.

Figure 8 shows the layer-type rectifier diode alongside a typical commercially available rectifying device. The overall diameter of the diode is roughly that of a 50-cent piece. The thickness of the germanium disk is only approximately 20 mils. This diode will carry 200 amperes average current and will withstand inverse voltages corresponding to 32 volts d-c output from a single-way circuit. Figure 9 is an artist's conception of a cutaway view of the encapsulated diode. The diode is soldered to a large copper block with internal openings so that water can be introduced for cooling purposes. The ability of the diode to withstand inverse voltage is greatly impaired if it is subjected to dirt, moisture, or corrosive material in the atmosphere. The illustration shows the care that is taken to seal it from these contaminating influences. The flexible anode

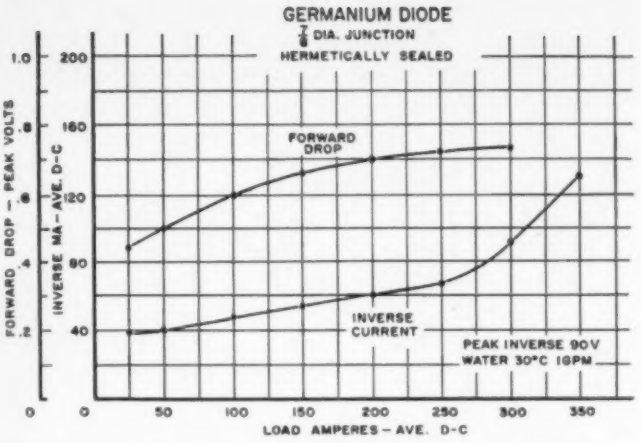


Figure 10 — Forward and inverse characteristics of a typical germanium diode are given.

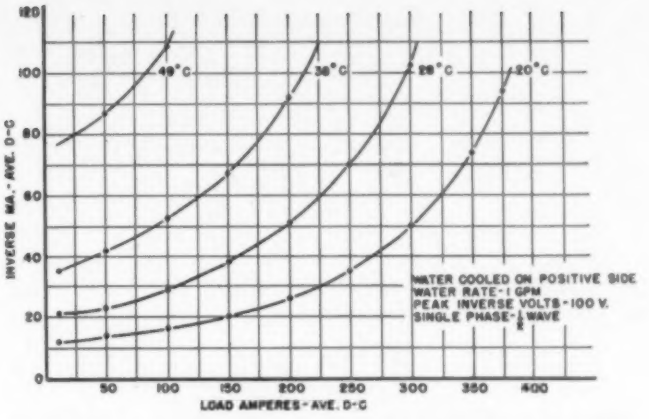


Figure 11 — The curves illustrate the variation of leakage current with temperature for hermetically sealed, germanium diode with ⅞ in. diam junction.

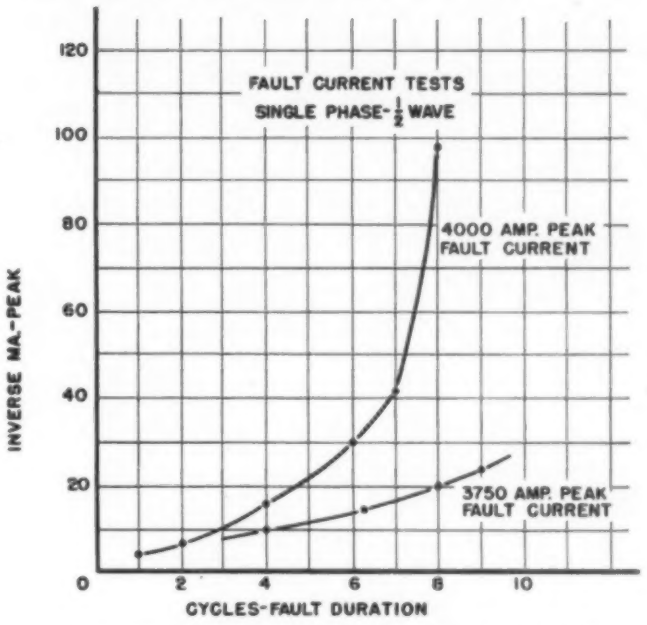
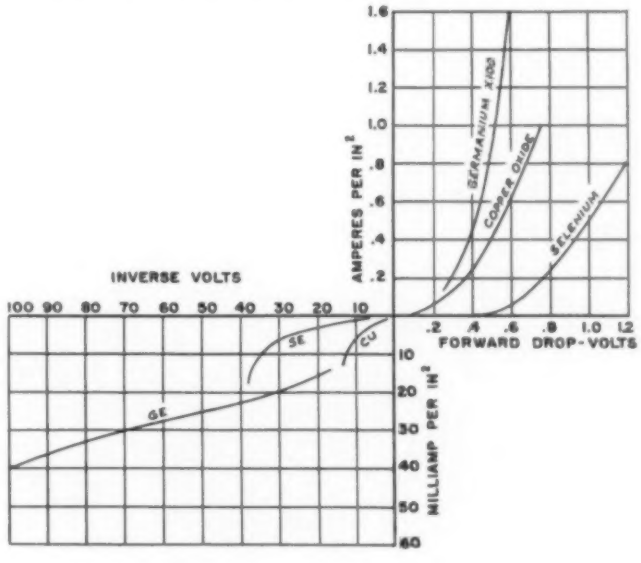


Figure 12 — Fault current characteristics of a typical germanium diode are given.

Figure 13 — Comparative forward and inverse characteristics of germanium, selenium, and copper oxide shows better characteristics of germanium.



lead is enclosed in a metal bellows to keep impurities within the lead from having access to the rectifier junction. A sleeve with glass seal is inserted over the anode lead and is welded at top and bottom to form an airtight joint. Following this, the enclosure is evacuated and filled with dry gas and permanently sealed.

What are the pertinent characteristics of this germanium semi-conductor rectifier? The most important is shown in Figure 10. The upper curve shows the voltage drop through the rectifier when it is carrying current in the forward or normal direction. At 200 amperes average d-c and 30 C cooling water, this voltage drop is only 0.7 volt. It is because of this characteristic that high efficiency can be obtained from the germanium rectifier. The lower curve shows the current that the rectifier allows to flow in the reverse direction. This is approximately 60 milliamperes under rated load conditions with an inverse voltage of 90 applied. If the rectifier is operated at lower forward currents with resultant lower temperatures, the inverse current drops off; but if it is operated at higher forward currents, the temperature rises and a point is reached at approximately 150 per cent of rated value where the inverse current increases quite rapidly.

Figure 11 illustrates clearly the effect of temperature. The curves are drawn for a peak inverse voltage of 100 for various temperatures of cooling water. With 49 C cooling water the inverse leakage is almost 90 milliamperes, when a unit is operated at only 50 amperes. On the other hand with 20 C cooling water, the unit can carry over 350 amperes forward current before an equal leakage prevails. The increase in leakage is a logarithmic function of temperature and forward current.

Figure 12 shows the ability of the germanium diode to withstand fault current. If it is applied in a circuit where the fault current is 4000 amperes, the leakage remains small for the first few cycles but increases asymtotically after eight cycles. However, with a fault current of only 3750 amperes, the leakage current remains at reasonable values for a much longer period of time. From these curves, it is obvious that the unit should be applied in a circuit with proper parameters such that the forward current under fault conditions is below the critical value. It is further obvious that circuit protection should be provided to remove the fault in a few cycles.

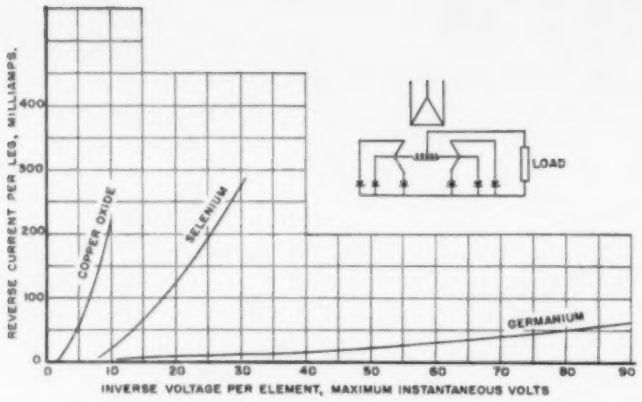


Figure 14 — Typical leakage currents for a 1200-ampere rectifier.

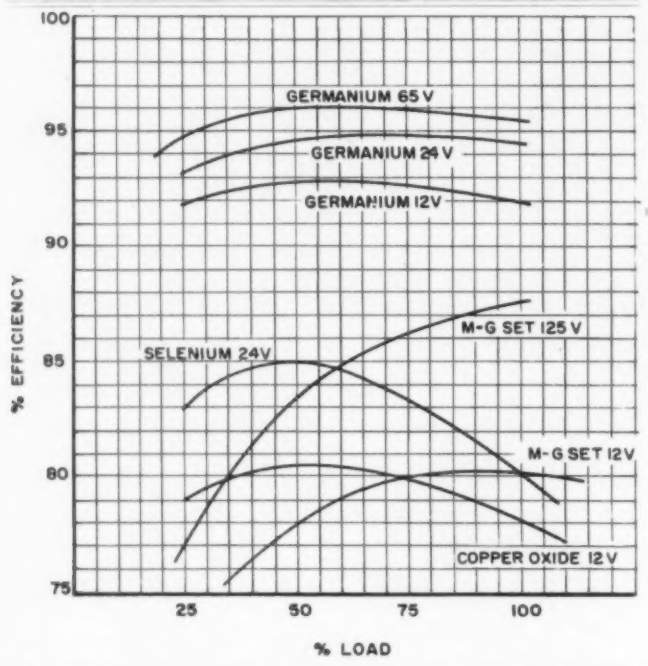


Figure 15 — Comparative efficiencies are given for several types of 4000-ampere low voltage conversion equipment.

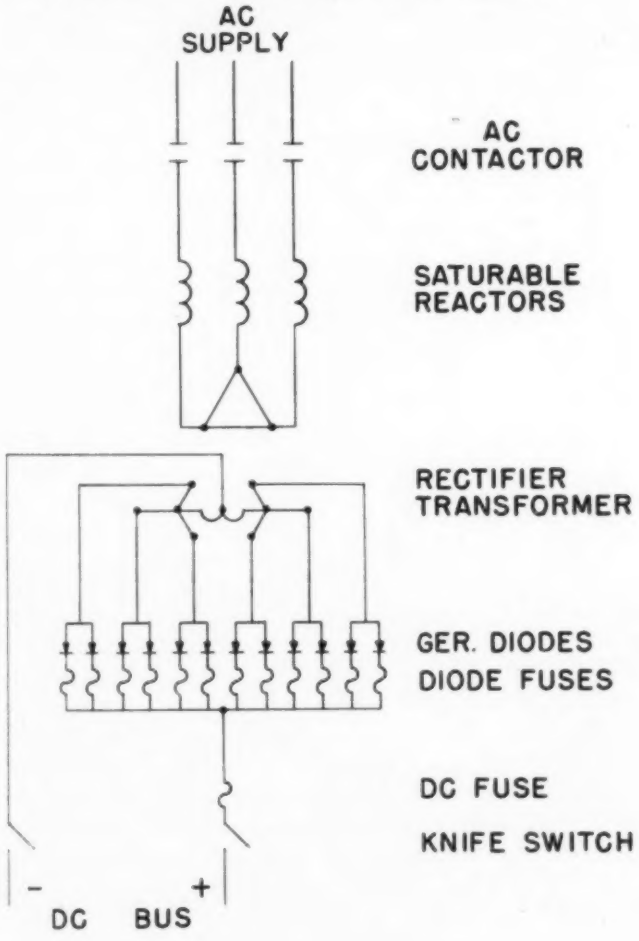
Another important characteristic of the germanium rectifier is the absence of "aging." These devices have now been tested for several years with no discernable change in forward drop. This means that high initial efficiency will be maintained and there is no foreseeable limit to the useful life of the device provided it is operated within its rating. Freedom from this aging characteristic of the metallic rectifiers simplifies the design of other circuit elements, particularly the rectifier transformer which will not need a multiplicity of taps. From an operating standpoint, it means that no forming period is necessary in process start-ups; the equipment can be initially adjusted for the particular current and voltage desired.

How does the germanium rectifier compare with other metallic rectifiers? It can be worked at a current density of over a thousand times that of selenium for the same forward drop. It can be worked at 300 times the current density of copper oxide for the same forward drop. Figure 13 shows the higher inverse voltages that can be withstood by germanium. Whereas the leakage for copper oxide becomes asymptotic at 15 volts and for selenium at less than 40 volts, germanium can withstand 100 inverse volts with little departure from a linear characteristic. Although the leakage rate per unit of area for germanium at low voltages is higher than that for copper oxide or selenium, the total leakage for a given rating is considerably reduced because of the higher current density at which germanium is applied. Figure 14 which considers a rectifier unit with a double wye transformer with an output rating of 1200 amperes illustrates this. At any practical voltage the copper oxide leakage is almost a hundred times that of germanium and the selenium leakage is at least of the next order of magnitude.

Figure 15 compares the overall efficiency for several types of conversion equipment at several voltages. The figures for the rectifiers include the losses of transformer as well as a rectifying device. The germanium advantage is obvious. If a 4000 unit, operated 6000 hours per year with a power rate of 1 cent per kwhr is considered, an annual saving of approximately $800 will accrue in favor of the germanium unit if the output rating is 24 volts.

Figure 16 shows schematically the equipment involved for a typical unit. It is not possible to vary the output voltage from a germanium rectifier by some such simple method as phase delay used on the mercury arc rectifier or field control used on motor-generator sets. Hence if it is necessary to vary the output voltage, means must be provided to vary the a-c voltage impressed on the anode of the rectifiers. The most com-

Figure 16 — Schematic diagram shows a 2000-ampere, 12-volt rectifier unit utilizing germanium diodes



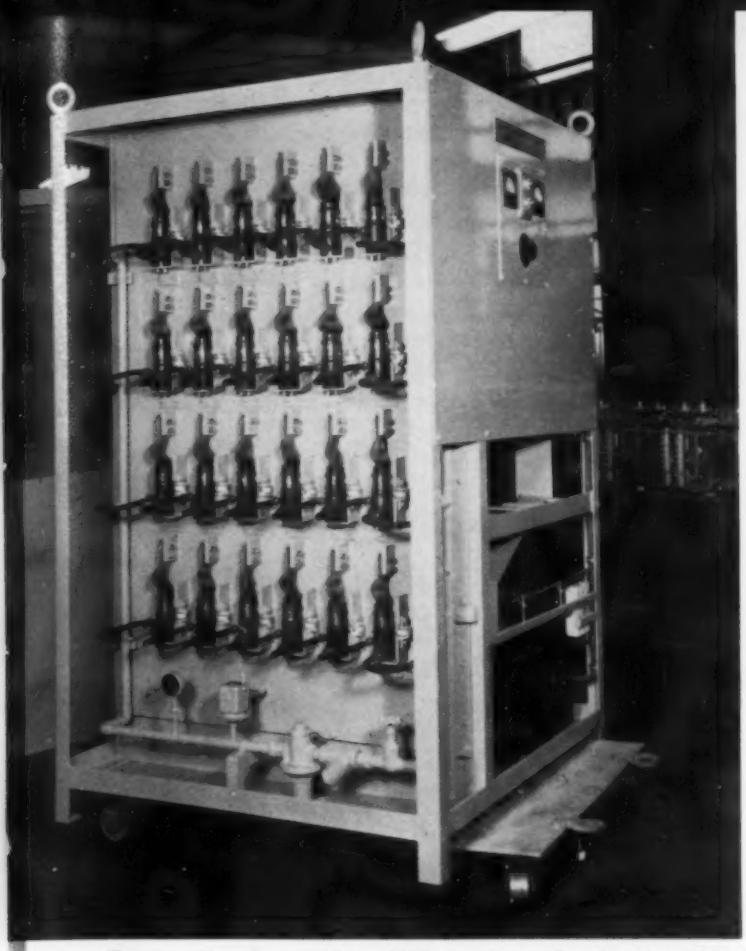


Figure 17 — A complete 4000-ampere, 12-volt assembled unit shows accessibility of individual diodes.

mon method of accomplishing this is by use of saturable core reactors in the a-c supply to the transformer as shown on the diagram. Induction regulators or tapped transformers are also used. The rectifier transformer is usually dry type. If the atmosphere is particularly corrosive, both the transformer and the saturable reactors can be liquid immersed. In spite of the low forward drop of the germanium rectifier, the loss per unit weight is very high and the thermal time constant is very short. Hence an individual fuse is placed in series with each diode to protect the installation from damaging current in case of an inverse voltage failure on any one diode. A fuse in the main bus offers protection from faults on the d-c side. A galvanometer type relay energized from current transformers on the a-c side supervises the trip circuit of the a-c contactor to furnish overload protection.

Figure 17 is a picture of a typical unit with side sheets removed. The transformer, saturable reactors and a-c contactor are mounted in the cubicle behind the panel which supports the rectifying devices. The diodes shown utilize direct water cooling. Liquid immersed diodes have also been extensively applied. Due to the low temperature restriction, air cooled units have found only very limited application in power ratings.

Unit ratings up to approximately 6000 amperes are accomplished by placing several rectifying elements in parallel in each anode circuit. Common unit ratings are 2000, 4000, and 6000 amperes. Several units can be operated in parallel to obtain any desired bus capacity. Prevalent voltages are 12, 18, 24, 48, and 60. Below 32 volts a single-way circuit is utilized whereas a double-way circuit is used for voltages between 32 and 65. The cost of the complete unit will vary depending on voltage and special requirements of any particular installation. Figures of $100 and $200 per kw will probably bracket the range.

The germanium rectifier has been tested by the major manufacturers in their laboratories and shops for approximately three years. Some units have been in commercial service for approximately two years. By the end of this year, approximately 15,000 kw will be installed for industrial service in ratings varying from a few hundred amperes at 12 volts to several thousand amperes at 135 volts. Its future application in the steel industry will be extensive for two important reasons. Its high efficiency when compared to other forms of conversion equipment will mean appreciable savings in operating cost. Of equal importance, its characteristics do not change in time, there are no moving parts to wear, and its construction features will effect long life and low maintenance. It warrants serious consideration for low voltage high current d-c power supply.

DISCUSSION

PRESENTED BY

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J. E. Peebles: Mr. Hague has noted a demand of users to gain simplification of mercury arc rectifiers by elimination of the vacuum pumping systems. Since we have had considerable experience in the field of sealed rectifiers, a brief summary of this experience may be of interest here.

Our original sealed tube units were placed in operation in 1936. Today, there are more than 5700 of our sealed tubes in operation. Many of the original tubes placed in service before 1940 are still operating satisfactorily. During 18 years of experience, such a small percentage of these tubes have actually failed that the average ultimate service life of sealed tubes has not been firmly established, although it is expected to considerably exceed 10 years. The ruggedness of this type of tube is demonstrated by the fact that it is used by the major electrical manufacturers for railroad locomotive service.

In high current sizes, over 400 amperes, we have applied a sealed tank designed to be reconditionable. The word "pumpless" has been used to designate these reconditionable sealed tanks. The pumpless tanks have the same physical size, geometrical arrangement, and electrical rating as the conventional pumped or continuously evacuated tanks. These tanks therefore have the same ruggedness and ability to withstand heavy overloads as the pumped tanks. Pumpless rectifiers should be more reliable than pumped rectifiers since

the evacuating equipment was one of the most vulnerable parts of pumped rectifiers. In two locations where pumpless tanks were applied to main drives, the rectifier water cooling systems were incorrectly adjusted during installation; and both were punished with many arc-backs because of tank overheating. In one of these cases, more than 100 arc-backs were counted before the error was discovered and corrected. Both of these rectifiers are still in service with all of the original tanks performing successfully as though nothing had happened.

We now have, on order and installed, 330,000 kw of pumpless ignitron rectifiers, of which 107,000 kw are for steel mill service. Actually installed are over 104,000 kw of pumpless rectifiers, with 87,000 kw of these in steel mill usage. The initial commercial installation was made in 1948. In seven years, there has yet to be a failure of a single pumpless tank in regular operation. A few tanks damaged in shipment or installation have been discovered and replaced during installation. Many pumpless tanks are supplying power to steel mill main roll drives, such as those in hot strip mills. Pumpless rectifiers have been installed for both common bus and individual stand power supplies.

These pumpless tanks should rarely require reconditioning because of impairment of vacuum. Also pumped rectifiers become dirty, develop high arc-back rates and must be reconditioned about every ten years. While pumpless tanks will also need reconditioning because of the same dusting and erosion of metal and graphite parts, we expect the periods between reconditioning to be longer for pumpless tanks than for pumped, because the pumpless type are more vacuum tight and not so subject to contamination from the atmosphere.

The maximum allowable seepage which has been established for pumpless tanks is 100 microns per year. At this rate, it is estimated the vacuum of these tanks would be adequate for from 20 to 40 years. In actual practice, most of the tanks have seepage rates between 1 and 10 microns per year which means the life of the vacuum would be more than 100 years. Such a low seepage rate is possible only in well designed tanks with carefully controlled evacuating techniques.

The maximum allowable seepage rate of 100 microns per year for pumpless tanks compares with an allowable seepage rate for pumped tanks of one-third micron per hour, or 2900 microns per year. The pumpless tanks are approximately 30 times better in this respect than pumped tanks.

A large section of Mr. Hague's paper is devoted to a discussion of germanium rectifiers. We can tell of some practical experience in this field. We now have a total of 20,000 kw of germanium rectifiers sold and installed. Of this amount 10,000 kw are installed. The first installation was operating in December 1953. The largest single installation consists of two rectifiers, each rated 65 volts at 15,000 amperes d-c. This is in our own Pittsfield Works and produces power to generate hydrogen gas.

In February 1955, our first steel mill installation was made for a tinning line. Germanium rectifiers were used on this line along with existing copper oxide rectifiers and motor-generator sets. These germanium rectifiers are rated 12 volts, 5000 amperes. They have a two-hour rating of 125 per cent load with 200 per cent load for one minute. The units are controlled by saturable reactors, and the germanium cells are liquid cooled. These germanium rectifiers are not cooled directly by water but by perchlorethylene, which is pumped through the rectifiers and in turn cooled by water in a liquid-to-water heat exchanger. The units replaced some old copper oxide rectifiers, taking up something less than half of the floor space. They were mounted on a balcony.

The operating experience with germanium rectifiers has been good although there have been some growing pains. These problems are being solved one by one, and at present, the majority of our germanium rectifier installations are operating normally without any troubles.

Recently, two more steel mill installations, for a cleaning line and a tinning line, have been made. In one of these, the measured efficiency of the rectifier was 94.7 per cent exclusive of the induction voltage regulator used for d-c voltage adjustment. This installation produced direct current at 30 volts.

One application which should be considered for germanium rectifiers in the steel industry is that of hydrogen gas production. As you know, many steel companies generate their own hydrogen for use in annealing furnaces. We now have three steel mill installations for this use of germanium rectifiers operating at around 65 volts and 9,000 to 16,000 amperes.

From our nearly two years' operating experience with germanium rectifier installations, we predict a brilliant future for this type of rectifier. I am sure Mr. Hague will agree with me in this prediction.

J. F. Headlee: The estimated ratio of 35 to 20 for total power versus d-c power used in steel industry aroused curiosity as to relative amounts used at Fairless Works. A check of monthly records indicates a ratio of 40 to 12, a total of 49,750 kw installed rectifier capacity and a total of 108,000 kw installed rotating d-c generators. Rectifiers are 46 per cent of the total d-c conversion units.

1. Regarding the safety rail fence around the rectifier, it is insulated from ground potential for safety at Fairless Works. What is the practice at other plants?
2. Regarding the performance of germanium rectifier, the author states that "with 20 C cooling water the unit can carry over 350 amperes forward current before an equal leakage occurs." This brings up the question of mechanical refrigeration to keep the temperature of the cooling medium at a low value. Has this been tried and is it economically feasible to do so?
3. Does the estimated cost of germanium rectifier given as $100 to $200 per kw include installation?

F. O. Schnure: Our experience with the mercury arc rectifier, pumped type, indicates it measures up to all the qualifications set forth in Mr. Hague's paper. Nine such units are in service in our plant and the first, a 1000-kw, 250-volt unit installed at the ore wharf in 1943, has demonstrated a remarkable capacity to handle peak overloads.

The few troubles experienced have had their origin in the cooling systems, and were usually the result of

wear on the seats of automatic water regulating valves. This wear allowed the rectifier to operate at too low a temperature during low load periods. Needless to say, this point should have been observed by inspection.

Experience with low voltage metallic rectifiers leads to the observation that they are too sensitive to abuse from ordinary mill dirt and humid cooling atmospheres. Copper oxide rectifiers equipped with heat exchangers must be protected from condensation when the cooling media drops below the dewpoint, otherwise, sweating occurs, with disastrous results. Oil-immersed rectifiers with water-cooled heat exchangers offer an improvement.

A 10,000-ampere, 15-volt germanium rectifier is soon to be placed in operation. A superior performance is anticipated.

W. E. Gutzwiller: I would like to supplement this timely paper by a few comments pertaining, in particular, to mercury arc rectifiers. According to my records, the very first use of a mercury arc rectifier in an American steel mill was made in the Chicago area when the Republic Steel Co. placed a 1000-kw, 250-volt continuously excited type rectifier in service in 1936. This veteran unit, after nearly twenty years of operation, is still servicing economically the wire mill in which it was originally installed.

A typical example of a recent, well-coordinated 250-volt mill supply system using mercury arc rectifiers is that of the Fairless Works of U.S.S. In this mill, nineteen excitron type rectifiers were installed originally with a total capacity of 100,000 ampere, corresponding to 25,000 kw, to take care of practically all d-c powered material handling equipment. Some of the smaller units are of the sealed type, while the majority are of the 1500-kw pumped type. They are installed in d-c load centers, some in single, some in double-unit substations. The substations are interconnected for standby purposes through tie feeders, normally open. By properly locating and rating these substations, it was possible to keep the maximum connected d-c capacity on the substation buses from exceeding 3000-kw, thus limiting fault currents and permitting the use of the less expensive, conventional semi-high speed cathode switchgear.

Mercury arc rectifiers/inverters also have been used successfully for several years in two frequency changer installations, one rated 16,000 and the other 20,000 kw. The rectifier/inverters serve as flexible ties between 25-cycle, varying frequency steel mill power systems and fixed frequency utility systems, permitting accurately controlled power interchange in both directions. While this type of rectifier application does not strictly come under the subject of Mr. Hague's paper, it nevertheless is an interesting rectifier application peculiar to steel mills, and uses a direct-current circuit as a flexible link through which the two power systems are tied together.

Under the subject "700-volt Supply for Main Drive Motors," the paper mentions that the one-way characteristic of a rectifier is a serious deterrent in the use of a rectifier in connection with reversing mills and that two full capacity rectifier sections are required, one for forward and one for reverse operation. This need not necessarily be so. There are already a number of reversing mills in successful operation abroad and of impressive sizes, where only one full capacity rectifier section is used. The reversal of the drive is accomplished by reversing the polarity of the mill motor armature by a high speed reversing switch at the moment of zero current obtained as the result of phasing back the rectifier from rectification to inversion and vice versa. While I do not expect to see rectifiers universally used on reversing mills, it is my belief that we may see them applied to some reversing mill drives in the not too distant future.

C. S. Hague: First, I wish to thank those who have discussed this paper for giving us the benefit of their experience in the application of rectifier equipment in the steel industry. Certainly, the equipment is giving an excellent account of itself in service. Then, I wish to comment on some of the points raised in the discussions.

The idea of insulating from ground the guard rail or protective fence around open-type apparatus is indeed a good one as it will protect an operator who might simultaneously touch a frame at cathode potential and the ground rail when a stray ground exists on the negative. We know of several installations where this procedure is followed but have no figures on the percentage of the total. Of course, with the use of metal enclosed equipment this situation will no longer exist.

It is true that there are some reversing mill installations in Europe where only one group of rectifier tubes is used in conjunction with a reversing switch in the armature circuit of the motor. Another possibility is to reverse the field of the motor. However, both of these methods consume more time than the converter-inverter combination and introduce the additional maintenance associated with the switch.

We are surprised by the comment concerning the vulnerability of the pumping system for continuously evacuated mercury arc tubes. Although this may be true for some particular installations, published surveys of users in general show the pumping system to be an accessory requiring only a very small percentage of total maintenance. One steel mill installation recently came to our attention where the pumping system has given 10 years of faultless service without any maintenance attention.

In analyzing the seepage rates given, it must be remembered that the vacuum pumping system maintains an internal vacuum of one micron or less at all times for a continuously evacuated unit. Hence, over the years, its internal pressure averages much less than that for a sealed design where the leakage will accumulate and eventually require reconditioning of the tubes.

The space advantage for germanium rectifiers as compared to other metallic units is one we neglected to mention but is certainly an important one. In many plants this may be a highly influential factor in the choice of equipment.

Mechanical refrigeration of germanium rectifiers has been considered but, to our knowledge, has not been put into commercial practice. It is felt that the cost and complexity of the refrigeration system cannot be justified by the gain in rating capabilities of the rectifiers.

The cost estimates given are for equipment only and do not include installation allowances. Actually, in view of the light weight, small space and static nature of the units, installation costs should be relatively low.

Figure 1 — The original 36-in. blooming mill at Fontana produced slabs to a maximum width of 28-in. Rolls were changed by driving out the cap keys, removing the housing cap and lifting the rolls vertically from the mill.

HISTORY OF THE FONTANA BLOOMING MILL

Conversion of Fontana to peacetime steelmaking operation necessitated extensive changes to equipment and facilities . . . . key factor was the modification and additions to the blooming mill.

By REYNOLD MacDONALD

Superintendent of 46-in. Blooming Mill & Structural Mill, Kaiser Steel Corp., Fontana, Calif.

▲ THE Fontana blooming mill has been a very important factor in the growth of the Kaiser Steel Corp. and its history is particularly interesting from a technical and operating viewpoint. The original Fontana plant as authorized by the War Production Board in 1942 consisted of one 1200-ton blast furnace, four 185-ton open hearth furnaces and the plate mill. The plate mill products were rolled direct from bottom poured ingots after heating in the soaking pits.

The structural mill was added to the rolling mill layout by the second authorization of the WPB. It was located about 375 ft from the 36-in., 2-high reversing, blooming mill. The 29-in. structural mill consisted of two stands of 3-high and a 2-high finishing stand.

This original 36-in. mill was planned to work ultimately as a break-down mill in connection with a blooming mill, for which space had been reserved in the layout between the 36-in. mill and the soaking pits, but this blooming mill has never been installed, and the 36-in. mill of the original layout has had to perform the duties of the blooming mill and the break-down mill.

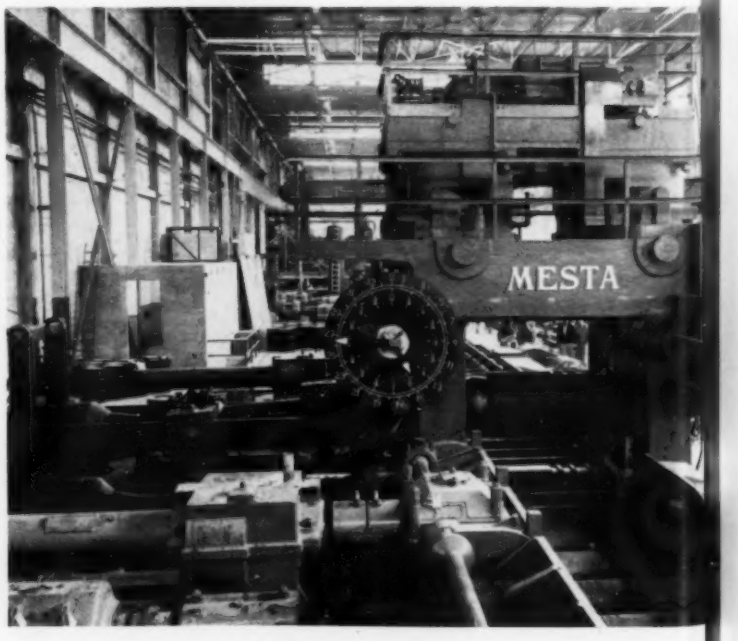
The 36-in. mill, as originally installed at Fontana, was a 2-high reversing mill driven by a 5000-hp motor, 50 to 120 rpm, 700-volt. The pinions were 36-in. in diameter and were connected to the mill rolls by universal spindles.

The mill rolls were 37½-in. maximum diameter for bloom shapes and 34-in. on slab rolls. The body length of the rolls was 82-in. The roll necks were 22-in. in diameter and operated in composition bearings, water-lubricated.

The original mill housing was of open top design and the roll lift allowed the rolling of slabs with a maximum width of 28-in. The mill tables and manipulators were of fairly heavy construction and, although not of the latest design, worked satisfactorily.

Both mills, the plate mill as well as the structural mill, were supplied with ingots by a battery of twelve soaking pits, the axis of which was running at 90 degrees to the axis of the rolling mills. An ingot buggy running alongside the soaking pits discharged slab ingots on one end of its run onto the plate mill entrance tables, and at the other end of its run discharged ingots for structural mill products onto an ingot transfer

Figure 2 — The original 36-in. blooming mill is shown from the roller's pulpit.



buggy which traveled the distance left open for a future blooming mill between soaking pits and 36-in. mill.

In the open hearth, the bottom pouring of plate mill slabs was done on ingot cars using sprue plates and fountains. On account of the diversified length of plates and the resulting necessity to tailor each ingot to the size of the plate to be rolled, the number of ingots and ingot cars was extremely large. This resulted in excessive work for the open hearth, the stripper and long track times which meant great heat losses. For all these reasons, the ingots reached the soaking pits in a cooled-off condition and tended to overtax the soaking pits, which resulted in downtime for the mill.

On account of these difficulties, it is easy to guess that the economics of the direct rolling process of plates were not too good, and it was clear that although this method could give the required results during the war, it could never be sufficiently profitable under peacetime competition.

Consequently, it was only natural that when the war came to an end in 1945, immediate efforts were made to free the Fontana rolling mill operation from the uneconomical wartime restrictions by abandoning bottom pouring and indirect rolling, and introducing instead, slabbing of ingots and rolling of plates from slabs. Extensive studies had been made on this subject, and in the spring of 1946, the proposed alteration and certain plant additions for the rolling of plates at Fontana were authorized.

Under the uncertain economic conditions existing right after the second World War, it was felt wise to keep the investment in the proposed mill alterations to a minimum, and thorough investigations were made to determine what could be achieved, making use as much as possible of the existing equipment.

The most conservative, and of course the most expensive way, was to buy all new equipment. However, this was unacceptable as it not only would have involved many months to get the new equipment, but also, due to necessary changes in foundations, would have caused long delays and production losses to install the new equipment. Fontana needed the conversion without loss of time, and for all these reasons this plan could not be accepted.

The other extreme involving the least expenditure and time losses, would have been to convert the existing equipment only. This possibility was given careful study and would have been entirely feasible except for the fact that the new slab width was to be 36-in. The roll lift of the existing housing was only sufficient to allow 28-in. wide slabs to be rolled from 26 x 34 in. ingots. For this reason, this plan had to be discarded also.

Considering all factors, the engineers and operators at Fontana agreed on a compromise between the two plans and their decision was a very fortunate one as it gave the operators sufficiently heavy mill equipment for the greatly increased production, and on the other hand, saved considerable installation costs by accepting the responsibility for a somewhat unusual installation.

The final decision was:

To install a new mill stand of closed design permitting a 38½-in. lift of the top roll and having an increased cross-section of posts. The new stand was to fit

Figure 3 — This blooming mill was installed in September, 1946. Average ingot weight rolled increased from 6300 to 16,000 lb. Maximum slab width rolled was increased to 35-in.

on the existing mill shoes, requiring only very slight foundation changes to accommodate new steel-yard rods, the linkage to the rod carrier, and the hook end of the counter-weight arm.

In addition, it was decided to use the existing pinions, spindles and spindle carriers, and to compensate for the higher lift of the new top rolls by inserting 9-in. fillers between pinion housing and shoe plates and also be-

Figure 4 — New housings were installed in November, 1954. Roll changing sled is in the foreground.

tween drive motor and motor bed plates. The raising of the pinions by 9-in. left the angularity of the top spindle unchanged from formerly existing conditions; however, this placed a fixed angularity of approximately 5 degrees on the bottom spindle.

It was this raising of pinions which created much discussion and controversy. It may be stated at this time that after several years of operation with raised pinions, Fontana did not experience any unusual detrimental results from the angularity of the bottom spindle.

Besides the above major points of the conversion, the following equipment changes were included:

A new mill screwdown was installed with a special coupling in the cross shaft to permit accurate leveling of the mill.

New manipulator side guards with longer finger stroke necessary for the turning of wide slab ingots were provided for entry and delivery tables.

The size of the new slab ingot was 30 x 42 in., which was 40 in. wide at the small end. This opening allowed the slab ingots to enter the mill without difficulty.

Beside the changes to the mill and the mill equipment which were done during the conversion of the mill, important changes were also made at later dates. These changes include alterations to the flume system for the scale removal from the 36-in. mill, a new manipulator side guard design and the installation of voltage regulators for the main mill motor. These changes have contributed considerably to the increase of production.

The change to the scale flume arrangement consisted in a separation of the scale flumes into three individual parts, a flume for each of the two mill tables, and a flume for the mill stand proper. All flumes were equipped with adjacent walkways and full head room to facilitate inspection and maintenance. A powerful water flushing and recirculating system was installed for each flume.

The results of the alteration of the scale flumes were most gratifying as many delays previously caused by accumulation of heavy scale and ingot fins were almost completely eliminated.

The revising of the side guards and manipulator was required due to the rolling of larger ingots and was designed by Kaiser Steel maintenance, engineering and operating personnel with excellent results.

The important change which took place in 1950, was the replacement of the original excitation of the 5000-hp motor driving the 36-in. mill, with new exciters and rotating regulator generators.

The installation of this equipment made it possible to reverse the mill from base speed in one direction to base speed in the other direction in 1.4 seconds. Actually the reversing speed was set at approximately two seconds due to the operators' preference and mechanical limitations of the other mill equipment—for example, mill tables. With the installation of the rotating regulator equipment, many relays and contactors of the control equipment were eliminated which in turn reduced the maintenance problem.

Up to now, this paper has dealt with the modifications to the 36-in. mill proper, but in order to get the increased production to the 36-in. mill and away from the mill, the rest of the mill equipment before and after the mill had to be modified also. This equipment included mainly the ingot transfer car buggy between soaking pits and mill, and the slab transfer and the slab depiler after the mill.

The 36-in. mill modifications were completed in September, 1946 with the result that the average ingot weight was increased from 6300 to 16,000 lb. The maximum slab ingot weight was approximately 23,900 lb. The track time, that is, the time from finished pour to charging of ingots in the pits, was decreased in this period from an average of four hours to two hours. The decrease in track time was a direct result of the larger ingots and the smaller number of ingots per heat.

The overall increase in the average tons per hour of heated steel from the soaking pits, increased from 72 tons per hour to 172 tons per hour. This figure, however, has to be qualified on account of the increase in number of pits from 12 in 1944 to 18 in 1951.

These figures represent the improvements gained from mill alterations and from the change in rolling mill practices, and certainly justify the effort as well as the investment.

By 1953 the Fontana plant had continued to expand. New facilities included an increase to 24 soaking pits, a continuous weld pipe mill, electric weld pipe mill, 86-in. hot strip mill using the plate mill 2-high and 3-high stands for roughing mills, and a tin mill installation. Steelmaking facilities included three blast furnaces and nine 225-ton open hearths. Productivity increased from 500,000 ingot tons per year to 1,530,000 tons in the year 1953, or an increase of 1,030,000 tons. Production of heated steel from the soaking pits increased to 198 tons per hour.

Due to increased production requirements and the rolling of larger ingots, the following changes were made to the blooming mill during 1953:

1. New entry and delivery tables, including new feed and housing rolls with individual drives, were installed, which were more rugged than those originally furnished with the mill.

Figure 5 — A new 5000-hp, 40/1000 rpm, motor was installed in November, 1954.

2. The entry table to the shear and the shear side guard drives were revised to increase strength and reduce maintenance requirements.
3. A new soaking pit ingot buggy, new laydown table and new ingot buggy to deliver the ingots from the soaking pits to the blooming mill were purchased. This new equipment was designed to handle 30 x 56-in. ingots and was a part of the overall program leading up to the installation of a new blooming mill capable of producing slabs 48-in. wide.

In 1954, due to production and yield considerations in the blooming mill, plate and strip mills and the tin mill, it was decided to replace the 36-in. mill with a new mill capable of rolling 30 x 56-in. ingots into a 48-in. wide slab for the plate mill and, also, a heavier slab to give larger coils to the tin mill.

A series of meetings were held with the manufacturer's engineering representatives, Kaiser Engineers, Kaiser Steel Corp. engineering department and mechanical, electrical and operating representatives to review drawings and specifications and endeavor to foresee problems and recommend modifications.

From an operating standpoint, it was desirable to widen the mill, which would result in lengthening the roll body to enable the maintenance of three edging passes, plus giving a larger bullhead pass required by the 30 x 56-in. ingots. However, due to the major changes required, this proposal was turned down with the result that the new mill, like the previous mill, was installed on the existing shoe plates, which resulted in the same length roll body of 82-in. Roll diameters and roll necks were increased two inches.

A new 46-in. pinion stand was installed together with new and longer spindles, which resulted in the bottom spindle having a fixed angularity of 2½ degrees and the top spindle with 5½ degrees in the down positions and 7¾ degrees in the up position.

Other changes included the use of hydraulic pressure for top roll balance replacing the old counterweight system, a sled arrangement for changing rolls, revisions to the feed and housing roll drives, revised chocks that carried all thrust in the outside chocks and increasing the height and lift of the side guards 12 in. for edging the larger ingots and slabs.

Electrical changes included:

The main mill motor—5000 hp, 50/120 rpm—was replaced with a 5000 hp, 40/100 rpm allowing for a 20 per cent increase in base delivered torque. The higher torque was to accommodate the larger ingots at the same average draft reduction increments. The net results were that tonnage would tend to increase without the addition of a greater horsepower motor, and a new electrical system that would be required to take care of the higher horsepower. The motor ultimate load relay was set at 300 per cent of motor full load to allow short duration overloads and still protect the motor from flashover or excessive heating.

The slip regulator and thermal overloads of the wound rotor induction motor which drives the flywheel and the two 2500-kw main generators, were adjusted to allow the motor to deliver 3500 hp above its 4500-hp rating. This is required during heavy drafts and long duration passes in order to restore energy to the flywheel more quickly and prevent the motor-generator set from slowing down to a dangerous speed level. However, if the set did slow down below 80 per cent of its rated speed, the mill bus voltage would be lowered, automatically, slowing down the mill and allowing the flywheel set to recover.

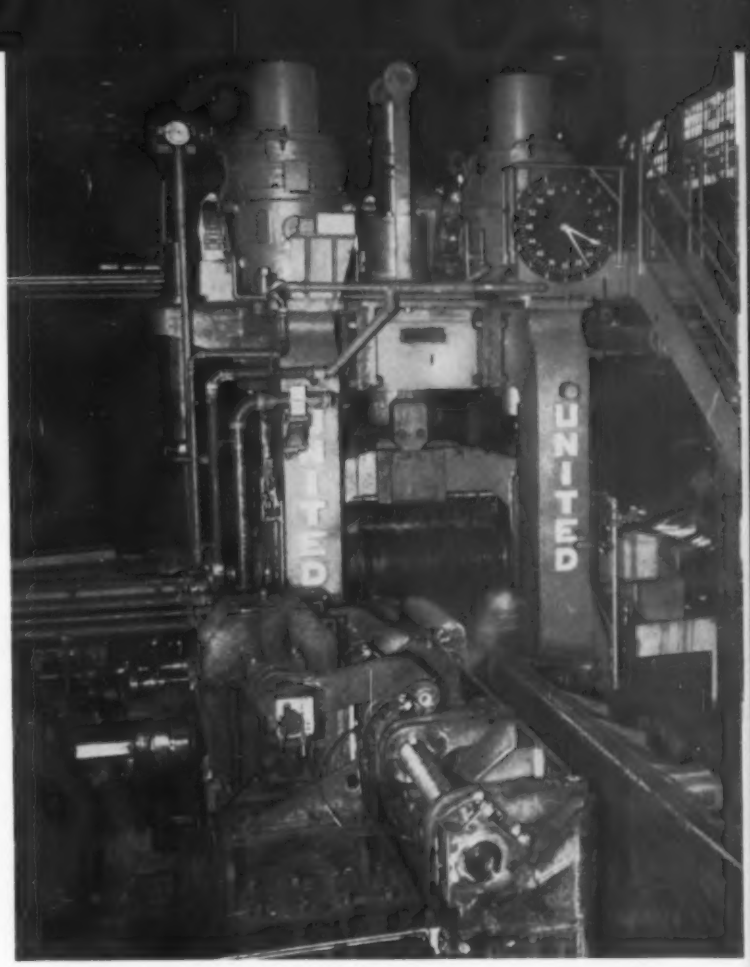


Figure 6 — This blooming mill was put into operation November 16, 1954. The installation of new housings, pinion stand and motor was accomplished during an 8-day down period. Maximum slab width rolled on this mill is 48-in.

The screwdown arrangement was redesigned for higher speed operation, using two 200-hp, d-c motors, two 150-kw generators, three 30-in. brakes and a variable voltage control system incorporating the most modern rotating regulators with current limit acceleration and de-acceleration. This method of screwdown control provides the shortest time for reaching top speed on both up and down directions, fast response to master controllers for small movements, accurate positioning and maximum utilization of motors, generators and mechanical equipment.

This new mill was installed in November, 1954. There were the usual problems in starting a new installation. However, with the cooperation of all concerned, many of these problems have been eliminated. Changes are still being made to improve roll change time, feed and housing roll drives, roll design, etc., which will probably continue for some time. However, increased production is expected, which is borne out by the fact that in March, 1955, 142,766 ingot tons were rolled for a new all time monthly record for the blooming mill at Fontana.

The increased blooming mill production from 1944 to date has been an important part in the development of the Kaiser Steel Corp. and its contribution to the productive capacity and wealth of its area.

POWER SYSTEMS

Chicago District—U.S. Steel

. . . . development of the power system in the Chicago district has met the constant challenge for expanding power requirements and product changes . . . . power system has a capacity of 384,900 kw and generates both 25 and 60-cycle frequencies . . . .

By K. E. DINIUS
Chief Engineer
South Works
United States Steel Corp.
Chicago, Ill.

▲ THE steel industry basically is in business to produce steel with the production of electricity strictly a secondary consideration. A steel plant, or steel mill, as it is commonly known today, may consist of anything from a small fabricating shop to a large integrated plant, where raw materials are processed through blast furnaces, open hearths, rolling mills, and fabricating plants to finished products. In all of these plants, however, electricity in large quantities is required to power the rugged, heavy duty machinery, and processing facilities.

Electric generating stations usually will be found only in the larger integrated steel plants, where large quantities of fuel or heat from blast furnaces, open hearths, and other processes are available and which would otherwise be wasted. This has been the basic reason for the inception and growth of the many large private power systems in the steel industry.

Individually owned plants in a given locality usually are complete units within themselves, having their own self-contained electrical systems supplied by power from public utilities, privately owned generating stations, or a combination of both. In some instances, there are a number of plants under common management, in a given area, where for various reasons the electrical systems are interconnected, and supplied with power from combinations of generating stations within the plants, and public utilities.

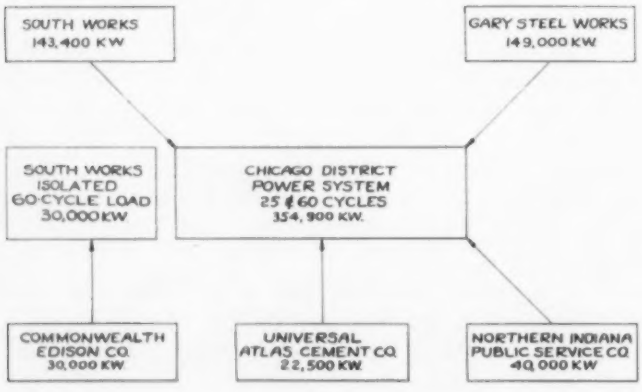
In the Chicago district, along the southern tip of Lake Michigan, the United States Steel Corp. has two integrated steel plants, and a plant of the subsidiary Universal Atlas Cement Co., where electric generating stations produce power in large quantities from waste heat and by-product fuels. Also, in this same district, are processing and fabricating plants requiring large quantities of power.

These plants of the corporation not only produce large quantities of power for their own use, but also require sizeable amounts from public utilities to meet their everyday requirements. The electrical network in the plants, and connecting the group of plants, is known as the Chicago District electrical power system.

The district system is supplied from five different power sources shown in block form in Figure 1. At South Works there is a rated generating capacity of 143,400 kw. At Gary Steel Works approximately fourteen miles away, there is a rated generating capacity of 149,000 kw and between South Works and Gary the Universal Atlas plant at Buffington, has a connected capacity of 22,500 kw. Connecting these power sources are tie lines which permit some interchange of power. Two public utility connections are capable of supplying 70,000 kw. The Commonwealth Edison Co. at South Works provides 30,000 kw and the Northern Indiana Public Service Co. at Gary supplies 40,000 kw. These two public utility systems are not connected by the plant tie lines.

The power concentrations in the Chicago district,

Figure 1 — The Chicago district receives power from 5 different sources.



generated and purchased, therefore total 384,900 kw, which is more than three times that required for a city such as Trenton, N. J.

The Chicago District electrical power system had its beginning at South Works some time prior to 1900. The first electrical applications were small direct-current generators, used for arc lights. The first plant generating station was built about 1900, and contained four steam engine-driven, 250-volt, direct-current generators, having a total capacity of 2800 kw. This power was used principally for street railway type motors applied to cranes, and to mill auxiliary drives. About this same time, the second generating station went into service with two steam-driven generators, each unit rated at 2000 kw, 2200 volts, 25 cycles. Boilers for these units were fired with blast furnace gas, one of the first electrical power applications of this by-product fuel, then largely wasted.

About 1904, the 2000-kw, a-c generator used at the St. Louis World's Fair in 1903 to supply electrical power for the Exposition, was reconnected for 2200-volt, 25-cycle service, and was installed with the two 2000-kw units. Somewhat later, a 7000-kw mixed pressure turbogenerator was installed at the same station. This unit used low pressure exhaust steam from blast furnace blowing engines, and high pressure steam from the blast furnace gas-fired boilers. This power was largely used for 440-volt and 2200-volt mill auxiliary drives such as pumps, blowers, crushers, and for rotary converters to obtain direct-current power.

The use of electrical power in relatively large unit blocks, or concentrations, was initiated by the advent of the direct-current main mill motors requiring large motor-generator sets. In 1907, a 4000-hp, 375-volt d-c motor was installed to drive a 30-in. universal plate mill. This was the first variable voltage, d-c reversing main mill motor drive installed in the United States. It was the forerunner of the versatile flexible, variable voltage d-c main mill motor drives which have become the backbone of the steel industry. It is a tribute to the designers who built this first unit with few, if any, precedents to guide them, that this equipment is still in normal service.

In 1908, four 2200-volt, 25-cycle gas engine-driven generators rated at 2000 kw each were installed, further utilizing blast furnace gas available.

About 1911, two 3000-kw, 2200-volt, 25-cycle turbogenerators were installed in a turbine station, largely utilizing exhaust steam from blooming mill and structural mill main drive steam engines.

Figure 2 pictures the type of 25-cycle, gas engine-driven generators, which were installed between the years 1922 and 1931, to further utilize available blast furnace gas. In 1930, two 10,000-kw, 25-cycle turbogenerators, receiving steam from open hearth waste heat boilers, were added. A 25,000-kw, 25-cycle turbogenerator was installed in 1937 to further increase the capacity of the system. The boilers supplying steam for this turbogenerator are designed for blast furnace gas, with natural gas and oil as supplemental fuels.

From time to time, obsolete generators have been removed, so that at present there are no generators in use that were installed prior to 1922. The present capacity of 143,400 kw is located in three power stations, one

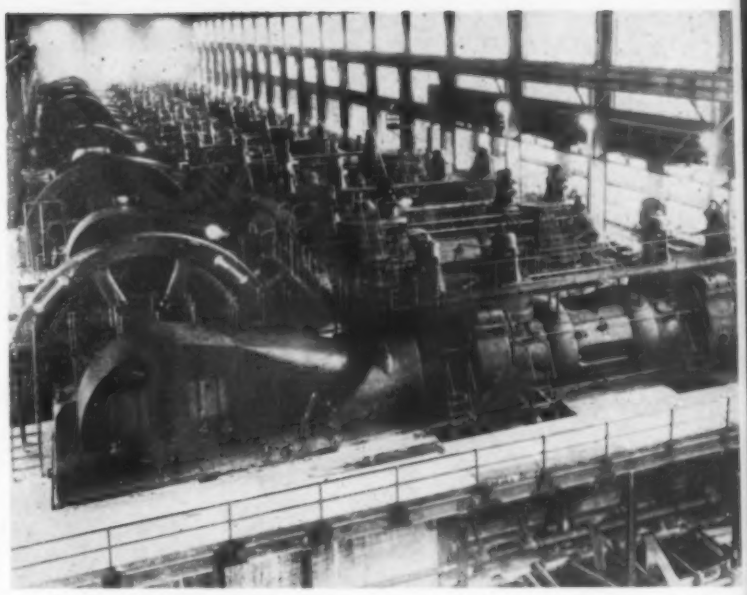
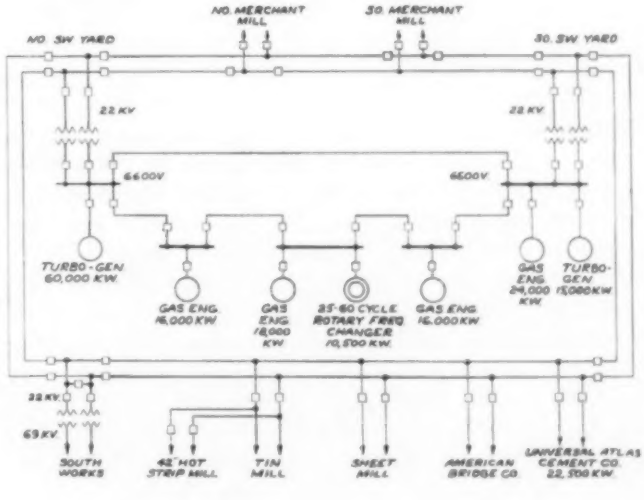


Figure 2 — A battery of 25-cycle, gas engine-driven generators was installed between 1922 and 1931.

of which contains the 25,000-kw, 25-cycle turbogenerator and a 60,000-kw, 60-cycle turbogenerator; another the two 10,000-kw, 25-cycle generators; and the third, nine gas engine-driven, 25-cycle generators having a combined capacity of 38,400 kw. The bulk of this power is distributed within the plant, either from a loop system at 23,000 volts, or direct from station buses at 6600 and 2300 volts. The general plant distribution system for mill auxiliaries is at 440 volts. As it is required, power is transferred at 69,000 volts over the district tie lines, between South Works and Gary.

The Gary Steel Works power system was begun in 1906-07, when the plant was started, with two 2000-kw, 25-cycle vertical turbines, and fifteen 2000-kw, 25-cycle, blast furnace gas engine-driven generators. Subsequently, nineteen gas engine-driven, 25-cycle generators, and two 7500-kw, two 15,000-kw, and one 30,000-kw turbine-driven generators were installed. Several of the original gas engine generators have been retired. However, the Gary Steel Works still has thirty gas engines, and five turbogenerators of 149,000 kw nameplate capacity. As indicated in Figure 3, this power is

Figure 3 — The 25-cycle power is fed into a 22-kv loop system.



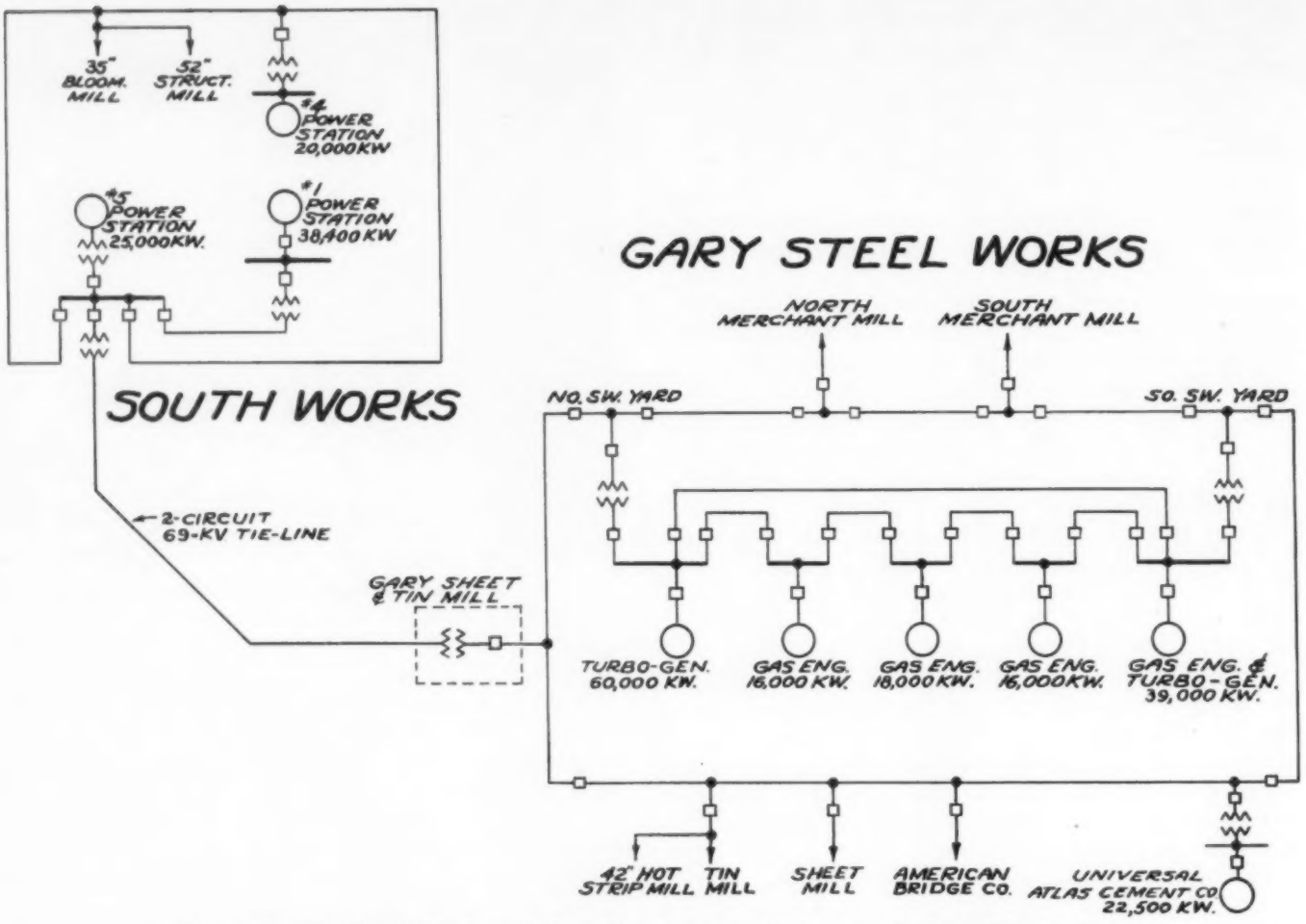


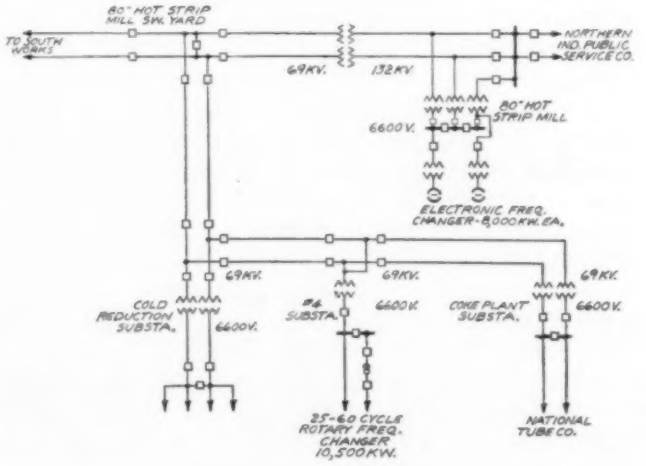
Figure 4 — The South Works and Gary 22-kv loops are tied in parallel by a 69-kv tie line.

delivered into a 22-kv loop system, which supplies all major power users within the plant, and also the Gary plant of the American Bridge Division. Three 7500-kw, 25-cycle turbogenerators installed between 1917 and 1928 at the Buffington plant of the Universal Atlas Cement Co., are also tied into the Gary Steel Works loop system. Steam for these generators is produced through the use of by-products from the cement kilns.

To bring the 25-cycle system up to date, Figure 4 indicates the Chicago district system in single line form, and shows the South Works and Gary 22-kv loops tied in parallel by a 69-kv tie line. The South Works-Gary tie line, about fourteen miles long, was originally a single circuit 22-kv, 3-phase, 25-cycle, No. 4 wire line, on wood poles. This line was installed about 1905 with three 750-kva transformers, to supply power to the Universal Atlas Cement Co. at Buffington, and later for the initial construction work at Gary Steel Works. Subsequently, increases in line capacity were made so that increasing requirements for the interchange of power between the two plants could be met. In 1937, this line was completely replaced by a double circuit 25-cycle, 69-kv tie line on steel towers.

Sixty-cycle equipment was introduced into the Chicago district plants with the construction of the 80-in. continuous strip mill at Gary Sheet and Tin Mill in 1936, with power furnished to this mill by the Northern Indiana Public Service Co., over two 132-kv lines, which are still in use. Following this installation some additional 25-cycle facilities were installed to meet current requirements, but the desirability of further expansion of 25-cycle facilities became questionable. For some years, there had been a trend in industry toward 60-cycle power, and a point had been reached where few industries operated on 25-cycle power. As a result, 25-cycle equipment was no longer produced in quantity, and some not produced at all. That which was manufactured demanded a premium in price over equivalent 60-cycle equipment, with much longer delivery. Therefore, it was decided that to the extent practicable, all new facilities for the Chicago district

Figure 5 — The 60-cycle facilities at the Gary plant are indicated by the schematic diagram.



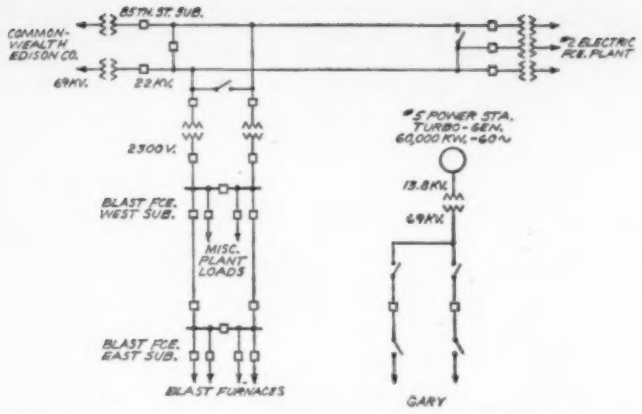


Figure 6 — The 60-cycle facilities at the South Works are indicated by the schematic diagram.

plants would be supplied with 60-cycle power, and that 25-cycle power would gradually be replaced.

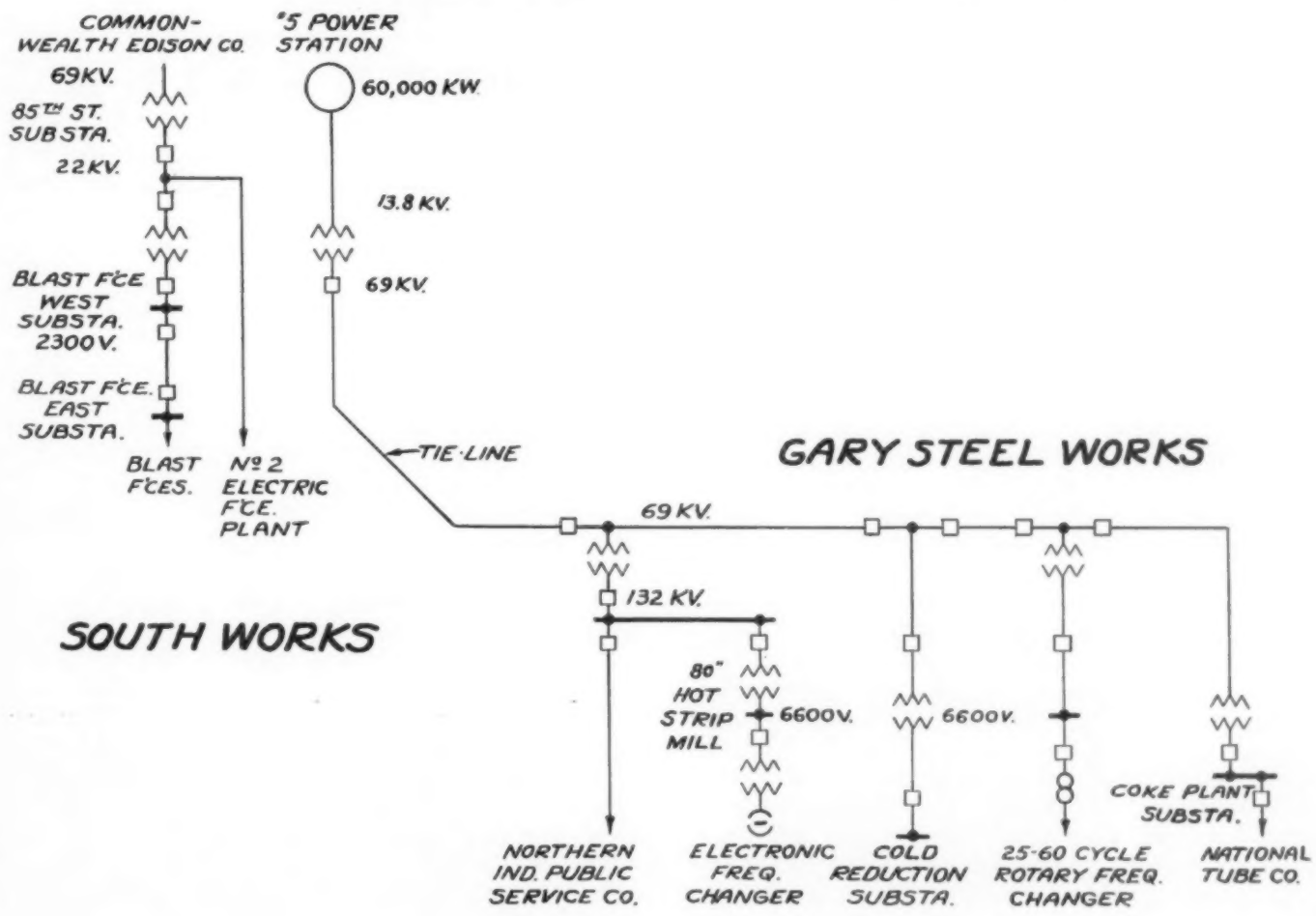
In 1943, an electronic frequency changer, rated at 6666 kw, and in 1948, increased to 8000 kw, was installed at the Gary Sheet and Tin Mill. This provided additional 60-cycle power for utilizing excess 25-cycle power, and thus reduced the high demand upon the public service company. An installation of 60-cycle conversion equipment at Gary Steel Works was made in 1948. It consisted of a 10,500-kw rotary frequency changer, operating off a separate 25-cycle bus, energized by four gas engine driven generators. This addition increased the reliability of 60-cycle power for Gary Steel Works' blast furnaces, and associated loads. At times, this frequency changer is used to supply wattless power to the system, in order to improve the power factor of the energy purchased from the Northern Indiana Public Service Company. Early in 1949, an additional 8000-kw electronic frequency changer was installed at the Gary Sheet and Tin Mill. The two machines are used normally to increase the supply of 60-cycle power to that plant but may be used to supply 25-cycle power, and reduce the use of supplementary fuels, when the availability of by-product fuels is low. Figure 5 shows the general arrangement of these 60-cycle facilities at the Gary plants.

The first 60-cycle equipment at South Works was installed in 1948, when two new blast furnaces were put into operation, with auxiliary equipment designed for 60 cycle. Until facilities could be constructed to transmit and receive the necessary power from the Commonwealth Edison system, two 3125-kva frequency changers, 25 cycles to 62½ cycles, were purchased from an idle eastern plant, for the initial operation of the furnaces.

When the Commonwealth Edison power did become available, the frequency changers were taken out of service. At the same time, two 15,000-kva and one 12,000-kva, 25-cycle electric furnace transformers were arranged for operation from the purchased, Edison Co., 60-cycle power source.

With the introduction of 60-cycle power in a plant where formerly only 25-cycle, or d-c were available,

Figure 7 — Single line diagram shows 60-cycle system for the Chicago district.



the demand for lighting, small tool and miscellaneous uses grows by leaps and bounds, creating an ever-increasing demand. The initial contract with the Edison Co. was for 20,000-kw on a 30-minute maximum demand basis. This was later increased to 30,000 kw.

In 1951, a 60,000-kw, 60-cycle turbogenerator was installed at South Works, where surplus blast furnace gas was available, to provide additional power for the district.

This additional power was needed primarily in the Gary district, and the double circuit 4/0, 69-kv tie line, between South Works and Gary, was reconnected so that both circuits, or either circuit, may operate on 25-cycle, or 60-cycle, as required.

Figure 6 is a single line diagram of the 60-cycle facilities at South Works.

The Commonwealth Edison power is used exclusively for isolated loads at South Works and is in no way arranged for parallel operation with the plant or district systems.

Figure 7 shows in simple line diagram, the 60-cycle system for the Chicago district. With this tie line arrangement, a continuous interchange of approximately 30,000 kw at 25-cycle is available and at the same time approximately 55,000 kw of 60-cycle power is transmitted from South Works to the Gary plants.

The transmission to Gary of this 55,000 kw or more power over a 4/0 copper line, makes this one of the hardest worked lines in the industry.

Figure 8 is a view of the switch yard at South Works, where this tie line terminates, and the centralized switching and distribution equipment is located.

Figure 9 is a view of the modern turbine station at South Works with the 60,000-kw, 60-cycle unit in the foreground and the 25,000-kw, 25-cycle unit is the background.

The district 60-cycle and 25-cycle systems, as mentioned previously, have a total installed nameplate capacity of 314,900 kw plus 70,000 kw from utilities. The economical application of this power to meet mill production schedules involves the efficient use of purchase power, and the efficient utilization of all available by-product fuel. To this end, the coordination of all district facilities is affected by district and plant load and fuel dispatchers. Extensive telemetering systems, with recording and indicating meters, give dispatchers a constant picture of by-product fuel, and of electric power generation and consumption. This aids the dispatchers in making necessary changes as required with plant operating personnel. Remote operation of substations and switching equipment for both the 25-cycle and 60-cycle systems is provided through supervisory control, which also gives the dispatchers notification of trouble.

Troubles do occur in the Chicago district plants occasionally. When failures of equipment result in the shut-down of facilities such as blast furnaces and steel producing furnaces, the immediate loss of production can be greatly aggravated by the loss of auxiliaries such as cooling water pumps. Therefore, reliability of operation under all normal and abnormal conditions has paralleled the growth and the development of the Chicago District electrical power system, from the very modest beginning at the turn of the century, to the present comprehensive combination of plant, and interplant power facilities.

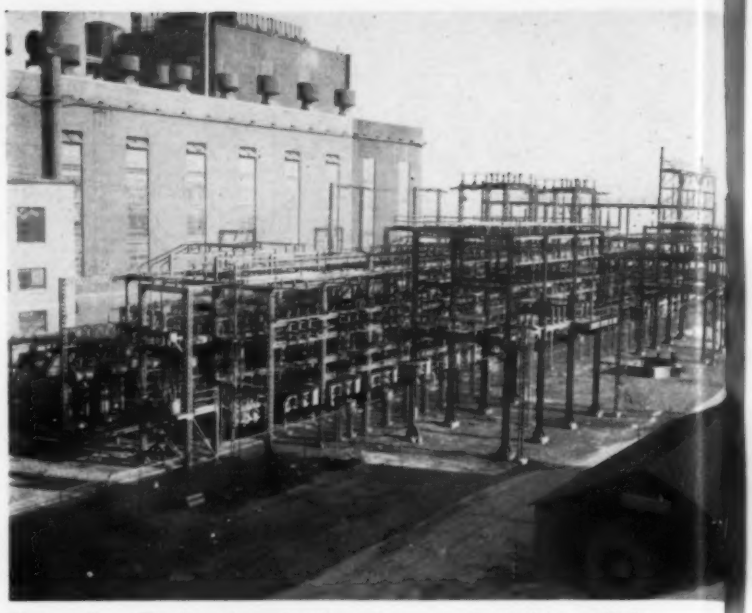


Figure 8 — Tie line terminates at one end at this switch yard at the South Works.

The development of the district system has met the constant challenge of expanding power requirements and industry product changes. In the future, the further development and growth of the Chicago District electrical power system, will be geared to the development and growth of the steel industry's changing production requirements.

DISCUSSION

PRESENTED BY

E. H. TURNER, Electrical Engineer, United Engineers and Constructors, Inc., Philadelphia, Pa.

F. O. SCHNURE, Electrical Superintendent, Bethlehem Steel Co., Sparrows Point, Baltimore, Md.

J. K. OSTRANDER, Consulting Electrical Engineer, United Engineers and Constructors, Inc., Philadelphia, Pa.

R. H. Turner: The subject of the Chicago District power system has merited a paper of this kind for a long while. I and my associates are particularly interested in this system because we have participated to some extent in its development since 1930.

We are interested in the loads that have developed, because in 1945 when they embarked on the 60-cycle system, we made a study in collaboration with the district engineers, forecasting the loads and laying out a basic plan for the ultimate 60-cycle system.

Now, neither the installed capacity nor the loads have followed too closely those predictions, but I think it has been demonstrated that having a basic plan of the ultimate system has at least given a sound basis for deviation as plant demands change. I think the future developments can probably be fitted in with that system very well.

F. O. Schnure: The description by Mr. Dinius of U. S. Steel's 385,000-kw power system in the Chicago area indicates that a growing steel plant is no place for an electrical engineer to become complacent, especially if 60-cycle power is being used to supplement an existing 25-cycle system.

At Sparrows Point, 60-cycle was introduced in 1936, about the same time it was adopted in the Gary and South Works. Since that time, the same demand for 60-cycle equipment, lighting, etc., has plagued us, until at the present time it is available in most sections of the plant. Eventually it will "fade out," but until it does, transmission and distribution in a plant with dual systems will not be simple.

J. K. Ostrander: The question often comes up "Why did they ever start with 25 cycles in the "first place?"—implying that a mistake had been made. I am sure that no mistake was made because the South Works plant was built in the 19th century when 25 cycles was as much of a standard frequency as 60 cycles. At that time it was not anticipated that 25 cycles eventually would become obsolete. Furthermore, 25 cycles was a good frequency for steel plant operation and in fact it still is. As late as 1913, some power companies were still building 25-cycle stations and at that time the Keokuk hydraulic station was constructed for 25-cycle operation after a considerable amount of study regarding the relative merits of 25-cycle and 60-cycle operation. However, soon after this time the advantages of the 60-cycle frequency for large steam turbine operation gradually caused 25 cycles to become an obsolete frequency. At the present time the handicap of having a 25-cycle system is not so much the inherent defects of this frequency as it is the various difficulties of using equipment which is produced in very small quantities.

Many steel plants now unavoidably are operating with both 25-cycle and 60-cycle equipment and regardless of the undesirability of having a 25-cycle system, these plants probably will operate on two frequencies for a considerable length of time due to the excessive investment involved if the 25-cycle equipment should be scrapped. Most steel companies have adopted the policy of allowing the 25-cycle system to diminish slowly and to build up their 60-cycle load.

Figure 9 — Turbogenerator in foreground is 60,000-kw, 60-cycle unit and that in the background is a 25,000-kw, 25-cycle unit.

About ten years ago a thorough study was made of the Chicago district power system in order to determine a plan which would permit the growth of the 60-cycle system so that ultimately the 25-cycle system could be abandoned. As a first step a turbogenerator, capable of producing about 75,000 kva, was installed at the South Works plant. This involved a considerable number of engineering problems. The turbine was installed at South Works because cheap fuel was available there, but the load which it would carry was at Gary, more than 15 miles away. As it was almost impossible to obtain right-of-way for new high voltage transmission lines to carry this power, it became necessary to utilize the existing double circuit 4/0 69,000-volt, 25-cycle line. The problem was further complicated by the fact that it was necessary to reserve one circuit as a tie between the 25-cycle system at Gary and the 25-cycle system at South Works. Although it might seem to be impossible to transmit most of the power from this turbine to Gary over a 4/0 line, actually this has been done quite successfully. It was calculated that this line might be able to carry continuously about 480 amperes which is equal to 54,000 kw with 95 per cent power factor. Although this current at times actually heated the hardware so that it became visible at night, this high load is still being carried. In addition to load carrying limitations, the problem of stability and voltage regulation became serious. At Gary the South Works turbine operates in parallel with the Northern Indiana Public Service Co., with a 12,500-kw rotating frequency changer and a 16,000-kw electronic frequency changer, the latter requiring a heavy wattless magnetizing current. The total reactance between the South Works generator and the Northern Indiana Public Service Co. generators was estimated at about 60 per cent on a 50,000-kw basis. Nevertheless, constant voltages have been maintained at Gary without undue difficulty.

This is probably the first use of high voltage single pole reclosing circuit breakers for an industrial plant. This became necessary for stability reasons. Numerous calculations indicated that if a line to ground fault should occur, the line would be unstable if 3-pole breakers should be used even though they should reclose in 21 cycles. But if single pole breakers should be used, the line would operate single phase during the short circuit and it would be stable with 3-cycle reclosing single-pole breaker operation.

In addition to carrying the power load, the line is equipped to operate with carrier current for relaying, for telephonic communication and for telemetering a load curve from South Works to Gary.

This line is not exceptional in regard to voltage, the amount of load carried or the distance over which the load is transmitted, but I know of no other line in this country which is doing a bigger job considering its physical limitations.

WELDING CLAD STEEL

precautionary steps should be taken to insure quality workmanship when fabricating clad steels . . . . . these pay off in economical vessels and joints which meet the requirements for which they are designed.

By WILLIAM H. FUNK
Manager, Technical Service
Lukens Steel Co.
Coatesville, Pa.

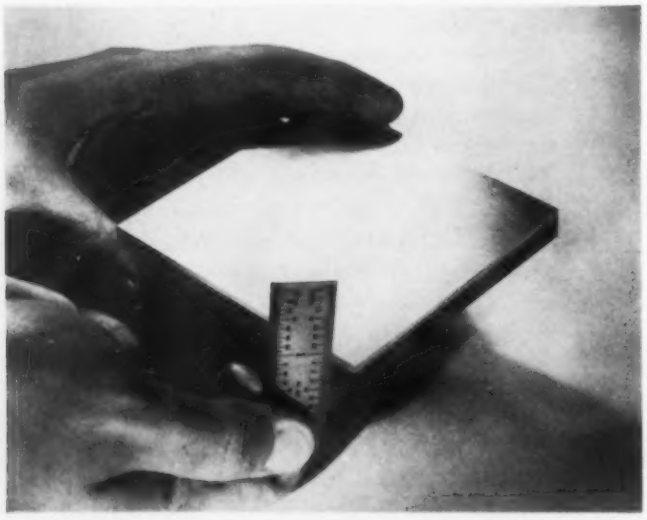
▲ THIS discussion will be based on the assumption that clad steel has been selected as the proper material of construction for the service to which the fabricated item will be applied. The probabilities are that the corrosion resistant qualities of the cladding material will have been major influencing factors in selecting the particular clad steel. It follows, too, that the clad steel has been selected as the economical material of construction, either from the first cost standpoint or for the over-all economy through the life of the piece of equipment. It will be assumed, also, that the weldment, whether it be a vessel or another piece of equipment, has been designed structurally to withstand any loads which might be applied in service.

The specific area for consideration, then, is that of working with the clad steel, taking it through the various stages of fabrication and welding to produce the desired end product and to produce it in the quickest, easiest, and most economical manner.

Clad steel is a bi-metallic plate product. It is generally formed in the steel mill by a procedure involving heating to 2100 to 2350 F and rolling through a plate mill. Through this operation, the materials are reduced in gage in a manner identical to that ordinarily performed in rolling plate and a complete and permanent bond is obtained between the cladding material and the backing steels. Figure 1 shows the two metals of a typical clad plate. The specific characteristics of both metals have not been changed through this cladding operation. If, for example, Type 316 stainless steel has been bonded to an A-285 carbon steel backing plate, there will still remain all of the chemical and physical qualities of the Type 316 stainless and the A-285 carbon steel. In addition, there is the advantage of having selected a product which has combined the characteristics of both materials in the proportion most desirable for our specific needs.

As we continue thinking in terms of Type 316 stainless-clad steel, we recognize that certain fabricating procedures have been developed specifically for that stainless steel, and they vary from those used for carbon steel. This is true for any of the materials which are commonly used for cladding, such as nickel, monel, inconel and many other types of stainless steels. The peculiarities of these different procedures at times appear comparatively difficult with respect to handling carbon steel. However, the benefits which will be gained in service by the use of these special alloys justifies the extra care required for their fabrication.

Figure 1 — The clad operation does not affect the characteristics of the two metals which compose the plate.



The procedures for processing clad steels must be given the same consideration, and we can say in general that some of the fabricating techniques applicable to clad steel are considerably easier than the techniques which must be applied to the same alloy materials if they were solid, and, in no case, are they more difficult.

Clad steels can be fabricated by shearing, punching, bending, rolling, spinning, flame cutting, and/or machining. Shearing and punching should be done with the clad side up. If the sheared clad plates are to be welded, consideration should be given to the shear droop which is the break in flatness that occurs on the edge by the shearing presure. Subsequent edge preparation by machining will remove any evidence of the shear droop.

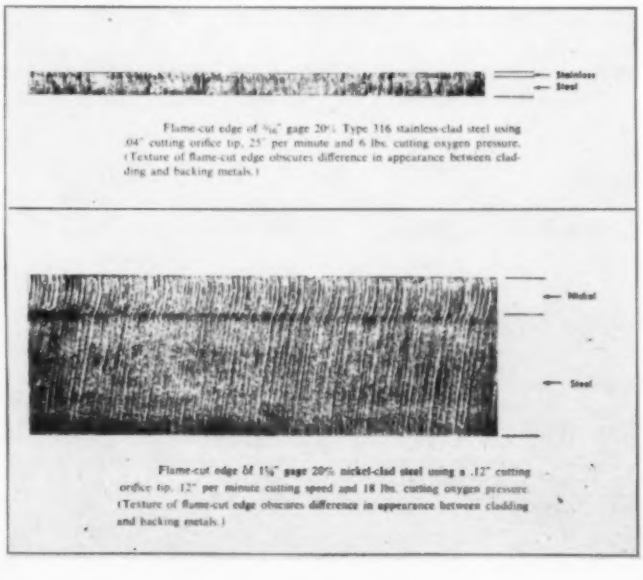
When bending or rolling clad steel, the characteristic of both types of material should be considered (Figure 2). Radii should be as large as possible, and compensation for spring-back should be made when bending. If the bending is particularly severe, the material should be in the annealed condition. When alloy steel backing is used in a heavy gage plate, bending and rolling should be performed hot. Since the corrosion resistant characteristics of some cladding materials is reduced if the material is under stress, cold working possibly should be followed by annealing. In shop handling, the clad side of the plate should be on top

Figure 2 — When clad plate is to undergo severe bending it is desirable that it be in the annealed condition.

to prevent accidental gouging and deep scratching. Bending rolls, dies, and handling tools should be clean of loose scale and steel particles to prevent their becoming embedded in the cladding surface. Figure 2 shows a clad steel cylinder just prior to removal from the bending rolls.

All of the family of clad steels, with the exception of copper-clad steel, can be flame cut, as long as the cladding is not more than 25 per cent of the total gage. It is not necessary to use a powder for this operation. The oxygen pressure used for cutting clad steels is considerably lower than would be used for cutting carbon steel. This low pressure is necessary to avoid undercutting between the cladding and the backing steel. Standard cutting tips may be used with the cutting orifice diameters varying according to the gage of the plate being cut. Either propane, natural gas, or acetylene may be used as cutting fuels for flame cutting clad steels. When flame cutting, the cladding should be on the bottom so that the flame will first strike the carbon steel. When starting the cut, the carbon steel should be heated to a temperature approaching its melting point, and then the cutting oxygen valve should be opened. In this way, the molten steel provides the heat necessary for cutting through the alloy material, and a smooth, clean edge will be obtained. This procedure is equally effective for hand or machine cutting. Figure 3 shows the flame cut edge on two types of clad steel; one is $\frac{3}{16}$ in. gage and the other is $1\frac{1}{4}$ in. thick. When cutting openings in clad steel vessels or other equipment, care should be exercised so that molten metal is not allowed to fall on the cladding surface and possibly affect its corrosion resistance. For such cutting operations, the cladding surface may be protected with a covering such as wet canvas. Copper-clad steel must have the copper removed by chipping in a groove at least $\frac{3}{8}$ in. wide at the bottom with the steel exposed. Flame cutting through the center of this chipped groove is done using the normal procedures for carbon steel.

Figure 3 — When burning clad metals it is recommended that the flame first strike the carbon steel.


Stainless
Steel
Flame-cut edge of 3/16" gage 20% Type 316 stainless-clad steel using .04" cutting orifice tip, 25" per minute and 6 lbs. cutting oxygen pressure. (Texture of flame-cut edge obscures difference in appearance between cladding and backing metals.)
Nickel
Steel
Flame-cut edge of 1¼" gage 20% nickel-clad steel using a .12" cutting orifice tip, 12" per minute cutting speed and 18 lbs. cutting oxygen pressure. (Texture of flame-cut edge obscures difference in appearance between cladding and backing metals.)

When clad steels are heat treated, the type of cladding material will sometimes dictate the procedure. Stainless clad steels require a neutral or oxidizing atmosphere. Reducing atmospheres should be avoided as they produce carburizing conditions that result in the loss of corrosion resistance. Also, an oxidizing atmosphere produces a scale that is more easily removed than that formed by a reducing atmosphere. On the other hand, nickel, inconel, and monel-clad steels should be heated in a reducing atmosphere. Otherwise, surface or edge cracking may develop during hot working caused by prolonged heating in the upper portion of the temperature range. Fuels high in sulphur may destroy ductility in the cladding material through embrittlement. Marking paint and protecting oil also should be removed from the cladding surface before heat treating for the same reason. Whenever possible, the plates should be heated with the clad side up. If this is not possible, the plates should be supported on clean steel rails or clean fire brick. The differences in the coefficient of expansion of the backing steel and the cladding will give no trouble upon applications of heat. Thickness and composition of cladding and backing plate will establish the definite type of heat treatment required. The holding time at the required temperature should be only long enough to ensure that the material is thoroughly heated. Hot working should be followed by a suitable heat treatment to be sure the material is in the proper condition for service.

Clad steels are welded by two basic methods, metallic arc welding and submerged arc welding. In the latter case, the cladding material is generally manually welded. Inert gas shielded arc consumable electrode processes are also sometimes applied when welding clad steels. An important consideration in welding clad steels, just as in welding any other material, is the use of electrodes that will develop characteristics in the weld zone similar to those in the parent plate. The characteristics which assume different degrees of importance, depending on the specific weldment, are the physicals, such as bending, tensile and yield strengths, and chemical characteristics for corrosion resistance and for temperature consideration.

In addition to selection of the proper electrodes, the design of the joint and the welding procedure must be satisfactory for the particular application. The most desirable joint is one in which the edges of the two

pieces to be welded together are butted in the same plane. Corner joints where the clad plates come together at 90 degrees to each other sometimes cannot be avoided, but every effort should be made to eliminate them when possible. These corner joints can be welded quite satisfactorily following the general considerations which will be described for butt joints. Tee and lap joints are also sometimes a necessity, but they, too, should be avoided whenever possible.

Considerations for butt welded joints will vary, depending on the gage of the plate and the accessibility to one side or the other of the joint. The basic procedure for welding from both sides of the plate will be

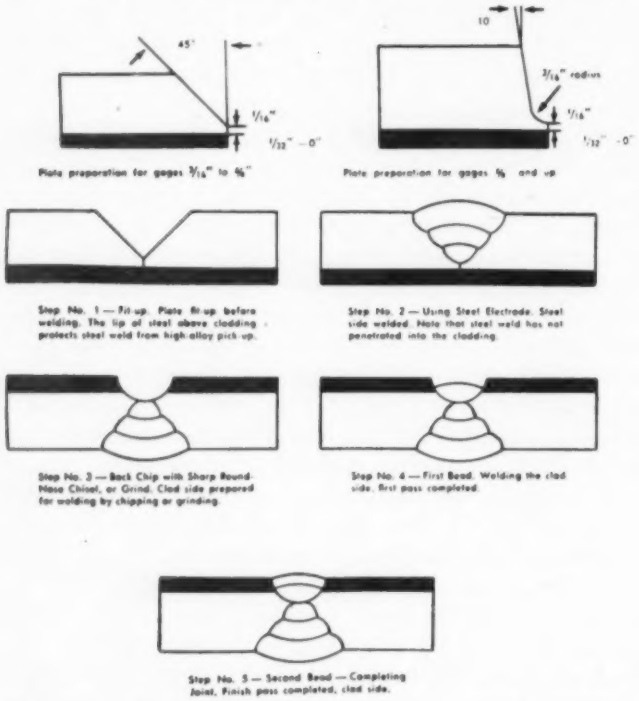

45°
1/16"
1/32" - 0"
Plate preparation for gages 3/16" to 5/8"
10°
3/16" radius
1/16"
1/32" - 0"
Plate preparation for gages 5/8 and up
Step No. 1 — Fit-up. Plate fit-up before welding. The lip of steel above cladding protects steel weld from high alloy pick up.
Step No. 2 — Using Steel Electrode. Steel side welded. Note that steel weld has not penetrated into the cladding.
Step No. 3 — Back Chip with Sharp Round-Nose Chisel, or Grind. Clad side prepared for welding by chipping or grinding.
Step No. 4 — First Bead. Welding the clad side, first pass completed.
Step No. 5 — Second Bead — Completing Joint. Finish pass completed, clad side.

Figure 4 — Standard welding procedure is illustrated in schematic sketch.

described first, and then variations to suit special situations will also be discussed. It is important to remember that this procedure is presented as a guide only. Any individual fabricator may find it advantageous to deviate to some extent, depending on his own individual situation.

For plates up to $\frac{5}{16}$ in. in gage, the edges should be machined accurately with no bevel. In assembling, a $\frac{3}{32}$ in. gap should be set between the plate edges. Welding of these light-gage clad plates can be done most economically by welding first on the backing steel side with 25/20 or 25/12 chrome-nickel electrodes, one pass should be sufficient, then wire brushing with a stainless brush instead of chipping or grinding on the clad side prior to completing the weld with the same type of 25/20 or 25/12 electrode..

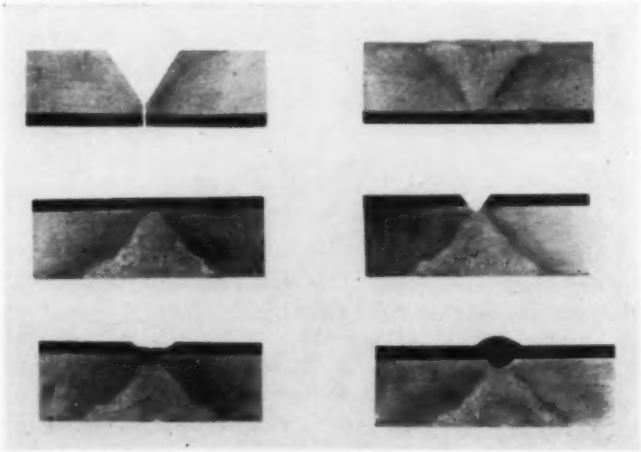
This is specifically so for stainless clad steels, for nickel and nickel alloy claddings other specially designed electrodes may be more desirable. Caution should be exercised in applying this procedure in applications involving high temperature cyclical service or other high stress producing conditions. However, when the service conditions permit this complete alloy welding procedure, the economies effected by the elimination of the chipping operation make welding of clad materials directly comparable to welding of solid stainless or other corrosion resistant materials.

If carbon steel electrodes are used for welding the carbon steel, the steel side should be done first and can be completed in one pass using an electrode that will develop the same characteristics of the backing steel. This weld should penetrate as deeply into the steel backing material as possible without penetrating into the cladding. The clad side of the joint should next be chipped or ground down to clean, sound weld metal. The chipped or ground groove should now be welded using 25/20 or 25/12 chrome-nickel electrode. This welding may be completed in one or two passes.

For plates from $\frac{5}{16}$ to $\frac{5}{8}$ in., the edges should be prepared by machining to provide a V-type bevel on the backing steel side (Figure 4). A $\frac{1}{16}$-in. lip of steel beyond the cladding material should be maintained at the root of the bevel. For plate gages over $\frac{5}{8}$ in. in gage, this V-type bevel can be changed to a U-groove. The edges of the plates should be assembled with as tight a fit-up as possible and with the cladding surfaces of both plates flush. This joint should be tack welded on the steel side. The steel side should be welded first using an electrode that will produce the same characteristics as exist in the backing steel. The root bead should fuse into the steel lip but should not penetrate into the cladding. When the steel side is completed, the clad side of the joint should be grooved down to clean, sound weld metal; actually the arc air process, similar to deseaming, is easier and cheaper, but chipping and grinding is widely used. Then this groove should be welded using an electrode which has been developed for the specific cladding material which is being welded. Figure 4 shows the welding procedure schematically through several stages of completion. Figure 5 shows this same procedure through the same stages on a welded plate.

In welding these heavy-gage clad plates, different shops may adopt variations of this procedure to accommodate specific needs of a particular job, or to provide the cheapest procedure commensurate with the qualities required. One such variation which is in common usage is a double V or a double U-groove. In this joint design, a nominal $\frac{1}{8}$ or $\frac{3}{16}$-in. thick lip is provided near the center of the thickness of the plate, and the cladding material is machined back $\frac{1}{16}$ to $\frac{1}{4}$ in. further than the edge of the bevel at the bond line. With this

Figure 5 — Appearances of welds made as outlined in Figure 4 are shown in this illustration.



joint design, the carbon steel welds are completed first up to the bond line, and the alloy material is over-laid with the properly selected electrodes. This type of joint has found preference among some fabricators for vessels subjected to high temperature service, or other conditions where cyclic stressing occurs.

Regardless of the details of the beveling in joints over $\frac{5}{8}$ in. in gage, some fabricators have found it economically desirable to weld from the backing steel side by the submerged arc process. Extra precautions should be taken when using this process to be sure the steel weld does not penetrate into the cladding metal. A thicker steel lip underneath the cladding may be sufficient, or one or more beads may be deposited manually in the bottom of the weld groove before proceeding with the submerged arc weld. In the case where the backing steel is welded by this process, the carbon steel for submerged arc welding should be killed material, such as A-201 in gages over 1-in.

There will be some cases where it is not possible to weld from both sides of a butt joint. Such blind joints can be satisfactorily welded whether the accessibility is from the backing steel side or from the cladding side.

Horizontal Position

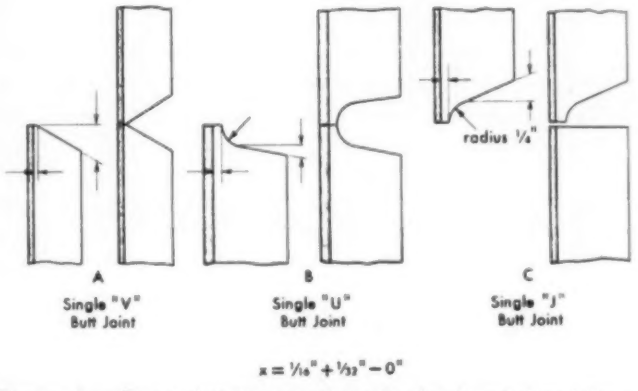


Figure 6 — Bevel details are given for horizontal welding.

A V-type bevel should be provided in these cases, and the edge of the plates should be separated by a gap of $\frac{1}{8}$ to $\frac{3}{16}$ in., depending on the gage of the plate being welded. When access is from the clad surface, a steel backing strip can be used to close the gap on the opposite side. The groove should be filled with a carbon steel electrode up to within $\frac{1}{16}$ to $\frac{1}{8}$ in. of the bond line, and the electrode which will duplicate the characteristics of the cladding material should be used to complete the weld. If access is from the backing steel side, a back-up strip of the same alloy material as the cladding must be used. One must use 25/20 or 25/12 chrome-nickel electrodes throughout this joint, with the electrode for the cover pass being one which is recommended for the specific cladding material.

The basic joint designs and procedures which have been discussed so far are valid whether the item is being welded in the shop with all welds positioned or whether it is a field erected job, in which case, there will be horizontal, vertical, and possibly over-head welding. In these different welding positions, any deviations which might be made for a carbon steel fabricated item may also be considered valid for clad steels. The beveling details for horizontal welding shown in Figure 6 are an example of such a deviation; also, for

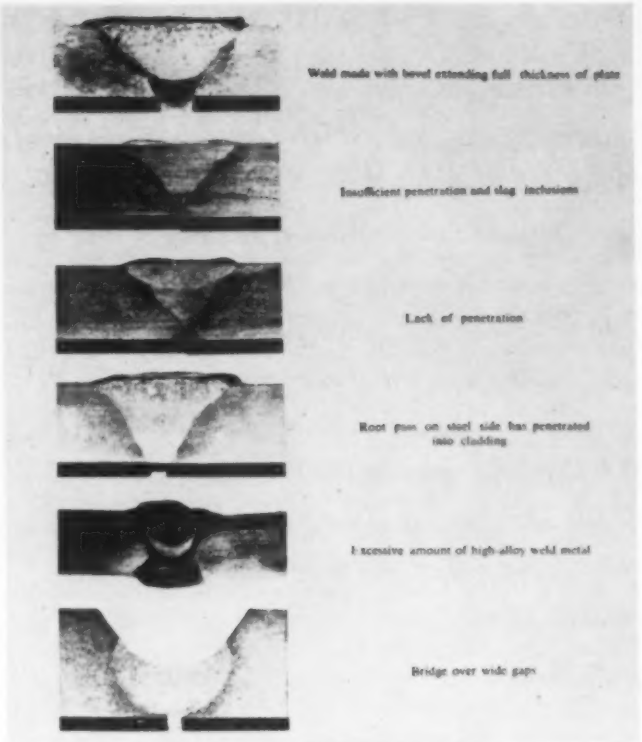

Weld made with bevel extending full thickness of plate
Insufficient penetration and slag inclusions
Lack of penetration
Root pass on steel side has penetrated into cladding
Excessive amount of high-alloy weld metal
Bridge over wide gap

Figure 7 — A number of common mistakes in welding steel clad metals are illustrated here.

horizontal welding, it may be found advantageous to allow a root gap of approximately $\frac{1}{16}$ in. Figure 6 shows how beveling might be designed for horizontal welding. "X" on the side indicates the root gap. Different welding electrodes for the carbon steel or backing material welded in the various positions may be found desirable as in the case of carbon steel fabricated work.

So far we have been talking about the procedures which have been found to be generally acceptable from all aspects. It is of some importance to understand why these principles for welding clad steels must be followed (Figure 7). If, for example, the cladding material is penetrated by the steel root bead, due to improper joint design, or poor fit-up, that joint may be a potential weak spot. Martensite will be formed in the root pass. Since martensite is lacking in ductility, such difficulties as cracking, inability to back-chip or to make bend tests, or a combination of these undesirable characteristics may result. Lines 1 and 4 of Figure 7 show effect of bevel for full plate thickness and poor fit-up. When the penetration of the steel root bead is too shallow (lines 2 and 3 show effect of using large diameter electrode and insufficient bevel opening), the metal to be removed by chipping or grinding from the clad side will be excessive and excessive amounts of the high alloy weld metal will be required. Line 5 shows too much alloy electrode used. Line 6 shows possibilities of bridging over a gap with AWS type E6012 or E6013 electrode when necessary. These conditions, when they occur, can appear to legislate against the possibilities of economic usage of clad steels. However, the normal precautionary steps to ensure quality workmanship and adherence to procedures for clad steel fabrication have been found in many shops to pay off in economical vessels and weldments which have fulfilled the specific requirements for which they were designed.

Heat treatment operations offer a number of possibilities for the steel industry . . . . development of equipment has enabled meeting rigid material specifications with carbon type steels with resultant economies in alloy elements . . . . other possibilities are the development of structural steel grades with high strength properties which could provide new markets for these steels . . . . ingenious mechanical equipment is a factor in keeping handling costs to a minimum.

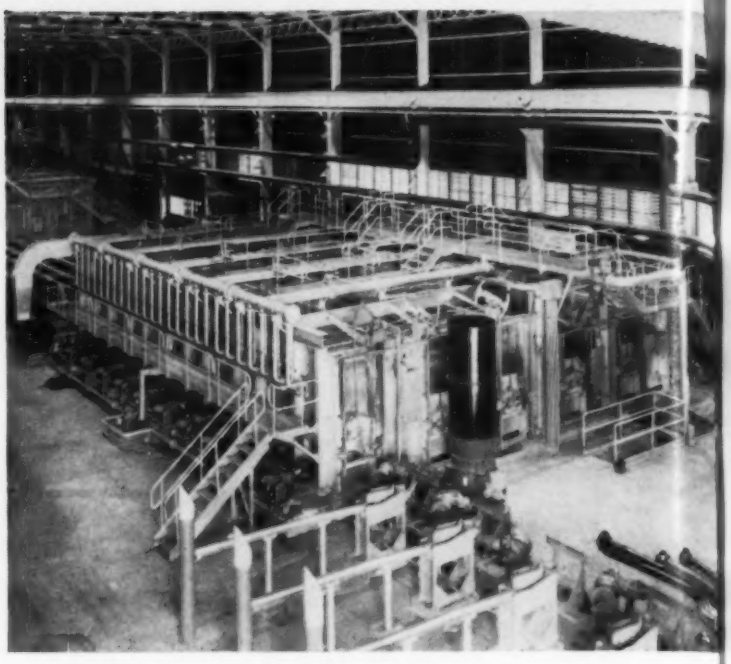


Figure 1 — Overall view of furnace.

Normalizing and Quench-and-Temper Heat Treatment of Steel Products

By JAMES MacGREGOR, Board Chairman, York-Gillespie Manufacturing Co., Pittsburgh, Pa.

▲ INASMUCH as steel is a major factor in the economic welfare of our country, the steel industry is constantly confronted with the problems of developing new production methods, to effect metallurgical refinements of steel products of every description. This is necessary to afford the ultimate consumers a better grade product at a reduced cost. Metallurgical research and development costs steel companies millions of dollars every year. This phase of operation, at one time, was a general service to the consumer, but in recent years it has become a mandatory requirement for self-preservation.

Steel, with its expensive production equipment, high labor and transportation costs, is still one of the most important, yet cheapest, commodities we have for the constant advancement of civilization. Until man can discover a suitable, economic substitute, the demands for this basic material in all of its forms will become more and more tremendous as we advance into the atomic age.

These increased demands for steel in its various forms, are not without consequence. Geologists are constantly warning about the depletion of our Grade "A" ores in the Superior and other North American regions, and the necessity of mixing these richer ores with lesser grade ores to conserve our supply. These warnings have not gone unheeded by any means, as can be seen from the combining of financial efforts of several competitive steel companies to exploit the Labrador ore regions and the heavy investments by other major steel producers in the South American regions.

However, finding new sources of ore supply is by no means the answer to the ponderous problems of greater competition and increased demands by consumers for better grade products with still higher tensile and compression factors. To meet these increased demands, the steel producers must resort to a greater use of alloying additives, a difficult thing to do, if they are to keep an eye to the conservation of these natural resources.

The worries of iron ore conservation are minor to the stringent controls and regulations mandated by the government during times of emergency, for the alloying materials such as nickel, chromium, manganese, molybdenum, vanadium, etc., used in the production of higher grades of steel. The quantity demands by the Atomic Energy Commission for many of these rarer metals has made the situation even more critical for the steel industry. Therefore, it is necessary that we

exploit every conceivable method of producing better grades of steel without the use of these alloying additives, or the use of a great deal less of them to produce our present high grades of steel.

This is not a difficult thing to do. The quality requirements of many grades of steel can be brought up to higher standards by various methods of heat treatment, where it is possible to alter the granular structure of lesser grade products to the equivalent of our higher alloyed products. Since the early 20's, the potentialities of heat treating steel products to obtain a wider variety of uses, has received more study by metallurgists than any other phase of steel refining. With all of the success of the various heat treating methods developed, it has been difficult to obtain suitable combinations of furnaces and mechanical equipment, that would overcome the many production problems involved in high speed and high tonnage heat treating of steel products to make these processes economically feasible. It has required considerable experimentation and development by steel producers and furnace manufacturers to arrive at some definite conclusions, before any successful continuous heat treating lines could be installed, and at that, there are many questions without answers.

Those companies who pioneered the normalizing and the quench and temper methods of heat treating of tubular products were equally confronted with problems that were very difficult to overcome. The most active of this phase of operation was energized by the higher grade quality demands of the oil industries for deep well casing having 80,000 psi minimum yield properties. This new product was given the identification symbol of N-80, and the American Petroleum Institute set up the following minimum standards for this product. The physical properties required to meet API standards for N-80 grade casing are 80,000-psi minimum yield strength, 100,000-psi minimum ultimate tensile strength and 16 per cent minimum elongation in 2 in. (using strip specimens). The necessity for deep well drilling by the oil industry resulted in a tremendous market for seamless casing in the N-80 class. The producers of these products were in a competitive fight for their share of the business. This grade product is usually made of normalized and drawn high manganese, molybdenum steel, the basic chemistry for which is 0.35 to 0.40 per cent carbon, 1.50 to 1.70 per cent manganese and 0.20 per cent molybdenum. The time cycle for normalizing and drawing this steel casing is presently based on an average time cycle of one hour per inch of product thickness in each furnace. In addition, the product should be rotated during transfer to effect uniform heating. The conventional furnace for normalizing and drawing is either the gravity or hand roll down type, or one using a drag chain type conveyor to motivate the pipe through the furnace. Both the roll down furnace and drag chain type are designed to rotate the product as it travels through the furnace, to effect uniform heating. However, the product was usually fed at ambient or room temperature into the 1650 to 1700 F hot zone of the furnace on straight line rollers. The stresses set up in the product from the hot gases hitting the top of the casing, the bottom still being cold, caused severe warpage of the product in a matter of seconds after entry into the furnace. This distortion of the product prevented rotation and it was, therefore, dragged or pushed nearly half way through the furnace until it absorbed sufficient heat to straighten out and roll the balance of the way across the hearth. These operations do not permit the full benefits of uniform heating.

The conveyor chain return in chain drag furnaces is from the underside of the hearth, allowing the chain and the dogs to cool during the return cycle. These chain and dogs, being normally thicker than the wall thickness of the product being processed, and not having the chance to fully absorb the operating temperature of the furnace, would absorb a percentage of the heat from the product. This resulted in chill spots which when normalized and drawn would not come up to the API standards for N-80 casing. The drag chains are usually guided in slots in the hearth, and these slots created a further temperature differential which aggravated the chilling of the sections of product in contact with the dogs. Chill spots thus created increased operating costs because a high percentage of production resulted in rejects, shorts and second grade pipe. To offset the effects of this adverse condition, a higher grade alloy was used so that the affected areas would come up to the API minimum standards, thereby further increasing production costs.

A step in the right direction to eliminate these heat treating difficulties in processing deep well casing, was taken by one of the producers of this product by introduction of the quench and temper process to produce high strength casing from plain carbon or comparatively low alloyed grades of steel. An announcement of the tentative success of the line was made known to the industry in 1951. This line was set up as an automatic, continuous operation capable of processing an average of approximately 5.4 tons per hour of a variety of sizes from 5½ to 9⅝ in. diam tubing. This line too met with many operating difficulties due to warpage of the pipe, caused by insufficient rotation of the product as it was transferred through the high heat furnace, the quenching station and the draw furnace. The distorted pipe would occasionally hang up in the furnaces or would not hit the limit switch actuating paddles that controlled the automatic operation of the line, which further aggravated operating conditions. Badly warped product is both difficult and expensive to straighten, usually requiring an additional pass through a draw furnace to eliminate the severe stresses affecting collapse resistance, resulting from heavy roller and gag press straightening operations. Warping of the casing as it was transferred through the furnaces created most of the difficulties with this line, and after the rolls were skewed to effect a slight percentage of rotation, the operating problems were greatly minimized and the line was operating somewhat successfully, but not at the high tonnage capacities desired.

Incidentally, insufficient rotation of the product in the furnaces is not the only major factor that creates the warped condition of the pipe during continuous heat treating operations. Where quenching is involved, it is imperative that a uniform quench to full penetration be maintained, if reasonably straight product is to be expected. The least deviation in the uniformity

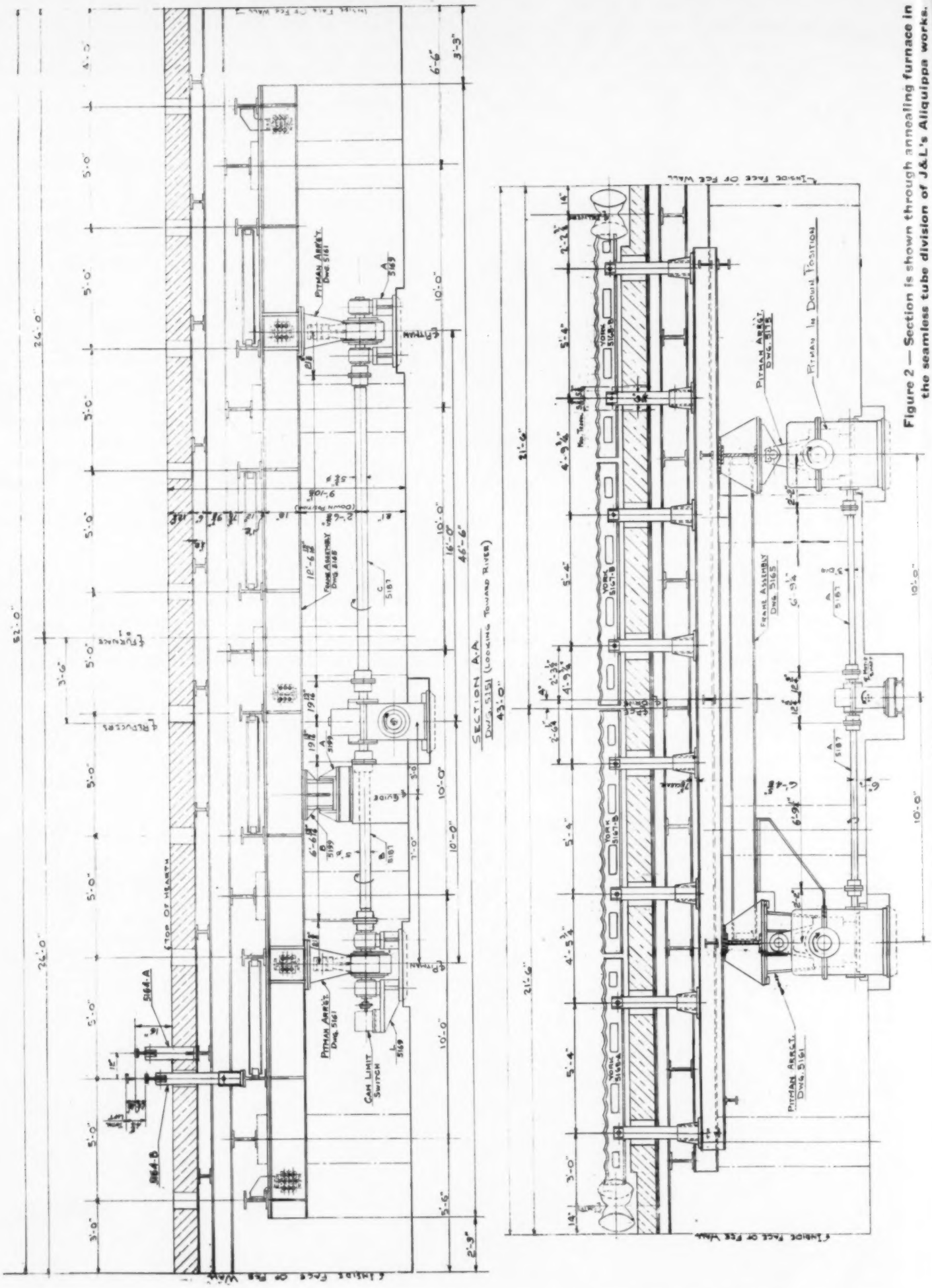


Figure 2 — Section is shown through annealing furnace in the seamless tube division of J&L's Aliquippa works.

of quench immediately develops unequal stresses, resulting in a piece of warped product.

At the time this first automatic line was announced to the industry in 1951, in view of the many operating problems which had to be solved, it was the consensus of opinion that unless something pretty unique was developed, the ultimate in dry heat methods had been reached. Of course, this thinking was stemming around ways and means of large tonnage capacity operations. The problems involved, however, by no means discouraged the potentialities of such an installation, and other companies instigated similar lines with an eye to operating techniques that would permit increased tonnage capacities. In 1954, Jones & Laughlin Steel Corp., a major producer of oil country goods, decided to go after the quench and temper heat treating problem and set their sights on 30 tons per hour. The line was to be set up on a continuous, automatic basis to handle a range of product sizes from 2⅜ to 10¾ in. outside diam in 50 ft-0 in. lengths. The weights ranged from 4.7 lb per ft to 82 lb per ft, and the new line had to handle this variety of product sizes without any physical modification of the mechanical handling equipment. With all of the difficulties encountered by others, and without suitable answers in sight, this was a big step.

We were awarded the contract to develop and furnish the furnace mechanical equipment to do the job. We were first confronted with the wide variety of pipe sizes, and the tonnage demands of a few of the more popular sizes. We knew we could vary the speed of the furnace mechanical equipment to increase the transfer speeds of the lighter gage product sizes through the furnaces. However, some of the smaller diameter products had heavier wall thicknesses than the larger diameter units, and we had to keep in mind that the average 30-ton per hour goal had to include all sizes and weights. This was solved by selecting a pitch for the furnace racks that would permit single pitch operation to transfer the product sizes from 2⅜ to 7 in. in diam and double pitch operation from 7 to 10¾ in. diam. This single and double pitch operation of the walking beam type racks, coupled with a variable speed drive, gave the right combination of factors we were looking for. There was one factor, however, which was at the time an indeterminate that gave a great deal of concern until the furnace was in operation. For this equipment to work successfully, we had to be within the limits of a 1½ in. warpage of the product in 50 ft-0 in. This was the big gamble for both the customer and ourselves. Based on past experiences of others, could we control the expected distortion of the product entering the hot zone of the furnace to these limits? Our general opinion was, if we could effect a sufficient rotation of the product entering the furnace, we would effect a uniform heating from ambient temperature into the 1650 F zone. Equal heat would mean equal stresses and, therefore, we should get either no distortion or, if any, at least it would be held within the limits of the 1½ in. camber allowed. That is exactly how it worked out. It was decided that the rollers be skewed to the near critical angle which afforded the maximum circumferential travel per ft of lineal travel for the entire range of product size from 2⅜ to 10¾ in. diam.

Figure 2 is a typical section of the furnace installed and put into operation in July, 1954. The furnace proper is fired with coke oven gas and the inside dimensions are 43 ft-0 in. x 52 ft-0 in. Both sets of rolls inside the high heat furnace are skewed to an angle of 30 degrees for effective rotation of the product entering the furnace, and the furnace delivery and runout conveyors are also skewed to the same angle to permit rotation of the product leaving the furnace into the quenching station. This rotation of the product through the quenching operation is essential in effecting a uniform quench to assist in maintaining that straightness of product so desirable. When the product has fully entered the furnace, a limit switch control paddle is tripped to actuate the kickoff to transfer the product from the rolls to the furnace racks. The design of this kickoff permits continued rotation of the product during this transfer. The furnace mechanism and racks proper are so designed that they continue to rotate the product as it is transferred through the furnace for every up and down motion of the operating mechanism. This permits the entire surface of the product to come in contact with the hot gases and thereby eliminates the complete dependency of gas circulation and reflected heat from the hearth to effect uniform heating. The continued rotation of the product, throughout the entire range of pipe sizes already mentioned, is very materially effective in helping to maintain that straightness of product during normalizing and tempering operations. All furnace equipment components are designed to operate to capacity in furnace temperatures of 1750 F without water cooling.

The only modification required to handle this wide variety of product sizes is the electrically controlled speed change of the mechanical equipment to increase the motion of product transfer to conform with the average operating basis of one hour in the furnace per inch of product thickness. Accurate temperature control is important for successful heating of the product. It is believed that this is the first installation of its kind where the furnace mechanical transfer equipment permits a full sealing of the hearth in a conventional furnace. This equipment design and sealing of the hearth is important for two reasons. First, it prevents the possibility of chill spots in the product during transfer, since all handling equipment, including the table rollers, is operating at furnace temperatures. Secondly, the design permits a definite controlled furnace temperature, a very important feature for metallurgical requirements and economical operation.

The Jones & Laughlin line is reaching capacity operations. Unfortunately, a full tabulation of its operating economies has not been made. However, some spot checking has been done. The high heat furnace, at temperatures of about 1650 F, using coke oven gas, is operating at 1,250,000 Btu's per net ton. Better than 20 tons per hr average was being processed at the time this check was made. It was mentioned that this was not a fair determination of operation, since material delivery to the furnace at the time this check was made was sporadic, preventing continuous full ca-

Figure 2 ... the seamless tube division of J&L's Aliquippa works.

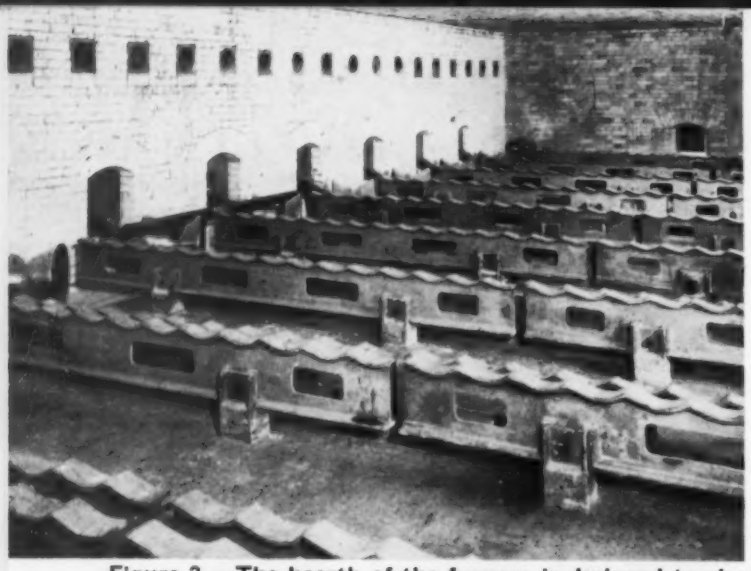


Figure 3 — The hearth of the furnace is designed to give good sealing.

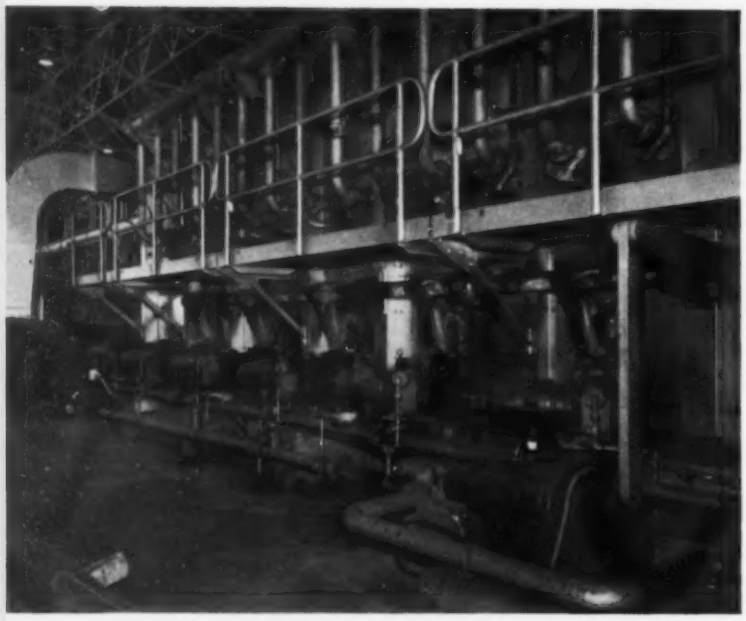


Figure 4 — This view is taken on the outside of the wall shown on the left in Figure 3.

Figure 5 — Casing is about to drop on the table rollers for transfer into the quenching unit.

pacity operation. It is expected that this figure will drop to approximately 1,000,000 Btu's per ton when the operation is running continuously to full capacity. The furnace gas consumption, at the time of the check, was approximately 50,000 cfhr and would result in a very moderate change to operate at full capacity. As a comparison to these figures, the barrel type high thermal release furnaces used to produce an average 5.4 tons per hr in the line previously mentioned operated at about 16,500 cfhr in the high heat furnace, or 2,574,000 Btu's per ton, using natural gas.

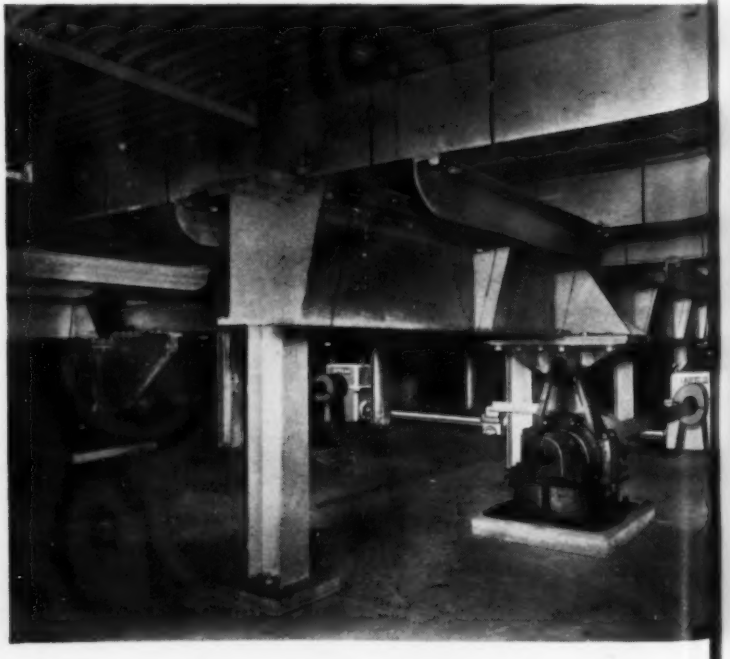
Figure 3 shows an excellent picture inside the furnace before it went into operation. Note the homogeneous poured hearth for overall sealing. The pocket for the movable rack is mounted in an insulated support, sealed from the underside of the hearth to prevent updrafts which would cause chilling of the product. Figure 4 is a view along one side of the outside of the furnace.

Figure 5 is a picture looking through the runout side of the high heat furnace. The quenching station is at the far end of this picture. The furnace was operating at 1650 F and it appears to be about a 9⅝-in. diam piece of casing about to drop onto the table rollers, for transfer into the quench unit.

Figure 6 shows a view from underneath the furnace. The longitudinal support beams resting on the pitmans are 46 ft-6 in. long and the transverse beams supporting the movable rack stands are 36 ft-9 in. long. The machining accuracy required on these units for successful operation had to be right the first time—there was no second chance. After the erection of this operating mechanism, the hearth was poured; and there was no way to get the units out for any corrections, unless two 50 ft-0 in. trenches at right angles to each other were dug, and then the units were skid out.

Figure 7 shows a continuous, fully automatic installation for tubular products. This line, of course, can be modified in many ways to satisfy any particular variety of product sizes and tonnage capacities re-

Figure 6 — View shown is from underneath the furnace.



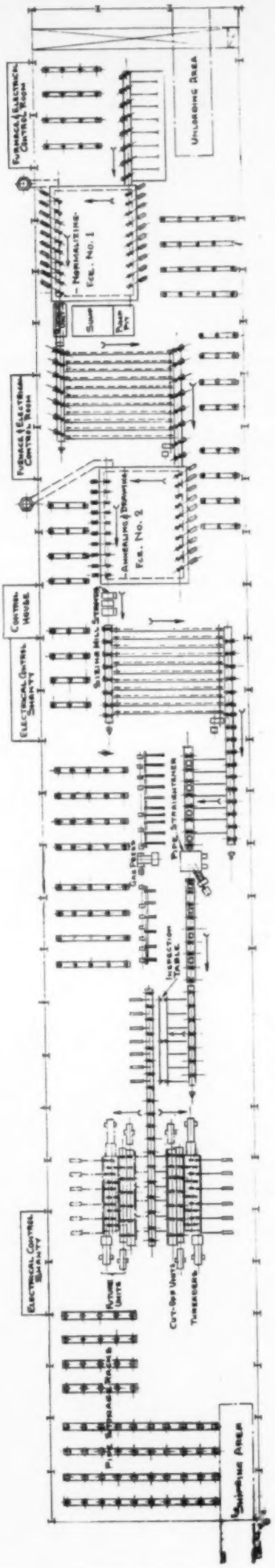


Figure 7 — Schematic design shows a continuous, fully automatic installation for handling tubular products.

quired. As it is shown, the line will handle from 30 to 40 tons per hr. The product is delivered by crane to the breakdown skids and is gravity delivered to the automatic feeder unit. This feeder is electrically controlled by the furnace equipment operation, to automatically deposit a piece of product on the delivery conveyor to effect a continuous flow of material into the furnace. The product, of course, is rotated as it advances into the furnace, and having fully entered, trips the limit switch control paddle operating the kickoff which transfers the product from the rolls to the furnace racks. The pipe is transferred through the furnace and deposited on the runout conveyor for delivery through the quenching station. The material continues on the quenching runout conveyor until it hits a flag switch, automatically operating the kickoff that transfers the product from the conveyor to the cooling bed. Incidentally, the product leaving the furnace is between 1600 and 1650 F and the temperature is dropped to about 300 F passing through the quenching station. The pipe is then transferred across the cooling bed and deposited on the furnace approach table feeding into the draw furnace, where it is handled and transferred in the same manner as in the high heat furnace. The product is deposited on the draw furnace runout conveyor, which is of the straight roller type, and fed directly into the sizing mill. Sizing mill operations in these lines are necessary because the product grows anywhere from 0.020 to 0.040 in. in diam during quenching. From the sizing mill runout conveyor, the material is automatically placed on the second cooling bed and transferred to the straightening machine delivery conveyor, accumulated on transfer skids from which it is fed into a rotary straightener, and from this operation, automatically transferred to the inspection tables. At this point, the casing is mechanically handled and manipulated for the inspector and is either transferred from the inspection table to a rejection bin, or is deposited onto another conveyor for transfer to the cutoff, facing and threading machines. The product is then mechanically fed successively into the cutoff, facing and threading machines and transferred into cradles, ready for stocking or hydrostatic testing. The full advantage of automation has been injected into this design. Except for the inspection operation no employee need touch the product from beginning to end.

For normalizing only, the product is brought up to temperature in the first furnace, and air cooled as it is conveyed across the No. 1 cooling bed. The product is transferred over the draw furnace delivery table on skids for deposit in a cradle, ready for crane pick-up.

The success of this line originates with the furnaces and their ability to maintain an output of reasonably straight product through the quenching station and sizing mill operations. This permits roller straightening of N-80 casing successfully without building up excessive internal stresses that affect collapse resistance to a point detrimental to the service required. The drilling of oil wells to the 20,000-ft level requires still stronger casing identified as P-110, normally made from steel of relatively high alloy contents. This casing has a minimum yield requirement of 110,000 psi and is being made with the same degree of success as outlined above for N-80. Because of the high as quenched

hardness of this grade product, it tends to crack or set up severe stresses affecting collapse resistance when run through the roller straightener and, therefore, was commercially straightened with a gag type press. However, with experimentation, it has been found that the P-110 can be straightened with a roller straightener but must be put through the draw furnace again to relieve the stresses affecting collapse resistance.

This method of high production heat treating of oil industry goods has resulted in a tremendous savings in alloying materials, since molybdenum additives are no longer used in the basic production, and the manganese has been reduced considerably. Higher and more uniform tensile properties are being achieved than could be obtained from the older methods, using high manganese and molybdenum steels. Needless to say, the furnace mechanical equipment is considered the heart of the success of this operation, and we have thoroughly patented the mechanism to handle a variety of products. Of course, without saying, the quenching operation is of equal importance to maintain a continuity of fairly straight product for continuous operation.

Another application for this type of furnace is to install a unit in the mill line proper, to normalize certain grades of steel products on a continuous basis at mill capacities. Furnaces for this type of operation are presently being designed to handle up to 100 tons per hr of a wide variety of product sizes.

It must be agreed that the outlined methods of handling and rotating tubular products to effect high tonnage heat treating operations, in conjunction with the tremendous savings in alloying materials that can be effected, opens the door to processing of other steel products in a like manner. The various finishing equipment units required for the successful operation of lines to handle a variety of steel products can be arranged in a continuous manner, similar to what has been done for the oil industry goods. The quenching stations can be modified in design to suit hardness penetration requirements. These are all possibilities.

For instance, the same typical arrangement as already explained can be used in a modified way for solid rounds. A comparable continuous automatic line can be designed to suit particular production needs, using whatever finishing facilities are required. Because of product growth whenever quenching is a part of the operation, a sizing mill following the draw furnace is usually necessary. From this operation, the product can go to straightening and from there, to facing, cut-off, centerless grinding, turning, oiling or other finishing facilities as required, including inspection stations.

We have expanded the basic rack design to rotate hexes and square products. This operates as follows: In position No. 1 the billet rests on the stationary rack with the movable rack just coming up in contact with it. In the second position, the billet starts to rotate in the "V" of the stationary grid. As rotation is effected, the long leg of the notch in the movable rack comes up to meet the product at the time it tends to rotate beyond its center of gravity, thus guiding and lifting the billet. The product is rotated until it again comes to rest in the next groove of the stationary rack as the movable rack revolves to repeat the operation.

We are, at the present time, developing a special mechanism to rotate square and other shaped products as they enter the furnaces, to afford uniform heat, and thereby keep warpage distortion of the product to a minimum. We are presently investigating the potentialities of alloys that may permit us to design our furnace racks and equipment to operate in temperatures of 1950 F as a reheating furnace. With this design, we will be able to maintain the sealed hearth design now in operation, which will permit controlled temperatures. If these alloys come up to expectations, we should be able to shorten the length of the furnace somewhat because of the fact we are rotating the product to effect uniform heating.

This same method of rotating the product can be used to advantage for rotating steel wheels to effect uniform heating for rim quenching and tempering operations. If a drag chain type furnace is used for this purpose, the same problem of chill spots caused by contact with the chains and dogs, as outlined for tubular products, has to be overcome. If small car or buggy type continuous furnaces are used, the wheel must depend on reflected heat and gas circulation to effect uniform heating of the underside of the wheel resting on the car. A motivating rack, similar to the equipment already described, rotates the wheel as it travels through the furnace for uniformity of heating. Here again, the supports and motivating racks would be operating at furnace temperatures, therefore, no chilling can take place until the rim is being quenched. An entire line can be set up for automatic operation to mechanically handle the wheel from the high heat furnace, through the quenching station and into the draw furnace.

A normalizing furnace that rotates the product, as outlined, may be the metallurgical answer to many problems presently confronting the new field of steel extrusion operations.

In conclusion, a phase of mass production heat treating will be outlined that could become vitally important to the steel producers and their ultimate consumers, for products of particular interest to the car building and ship building trades. We are presently improving the design of furnace mechanical equipment to rotate small structural shapes for continuous normalizing and quench and temper operations. If proper care is taken in the design of the quenching equipment, for which we already have ideas, reasonably straight product can probably be maintained. It may require a modification of rolling practice for these special heat treated shapes to effect a uniform thickness of webs and flanges in order to prevent distortion during heating and quenching. Here again, the entire line can be set up for continuous and automatic operation through the sizing mills, straighteners, saws or shears, and inspection. Just think of the many uses engineers and designers would develop for structural shapes up to 8 in. such as standard beams, wide flange beams, channels, T's and Z's with yield properties equal to 110,000, 120,000 or 150,000 psi. They may be of little value for long unsupported lengths since heat treating unfortunately does not help deflection. However, they could be used, where the design permits framing, in place of the heavier sections. The car building and ship building

industries could certainly use structural steel sections of this caliber to design railroad cars and ocean going vessels for lighter construction and heavier pay loads. The potential market that can be developed for high tensile steel products in these sizes is tremendous and would grow at a rapid rate, particularly if it can be purchased for a reasonable price. We all know that our steel price structure is contingent upon large tonnage capacity operations. Continuous, automatic heat treating lines, similar to that outlined to handle tubular goods, puts a new marketable steel product well within the realms of possibility. Who will be first to explore this new market?

DISCUSSION

PRESENTED BY

JAMES KNIVETON, Vice President, Selas Corp. of America, Philadelphia, Pa.

FRED S. BLOOM, President, Bloom Engineering Co., Pittsburgh, Pa.

J. J. B. RUTHERFORD, Chief Metallurgist, Tube Mills and Engineering, Tubular Products Division, Babcock and Wilcox Co., Beaver Falls, Pa.

JAMES MacGREGOR, Board Chairman, York-Gillespie Manufacturing Co., Pittsburgh, Pa.

James Kniveton: The paper presented by Mr. MacGregor is an interesting expose of a mechanical means designed to assist a conventional type of furnace to meet a thermal requirement. It is a pleasure to discuss the paper because of our early experience in the heat treatment of tubing and our continued close relationship with the subject through the installation of our gradiation tube heat treating lines installed in several plants.

Any improvement, either mechanically or thermally, that can be made on previously designed equipment is a laudable undertaking because steel producers wish to obtain the best end results. Our approach on the same subject has been different because we early recognized the need for uniform heating, and in the case of tubing, uniform cooling on an accelerated cycle. That, based on research work, established that an improved end product could be obtained if certain facts could be designed into production equipment.

During the year 1945 we entered into a program with one of our customers to develop a tube heat treating line for oil country tubular goods, the requirements of which were to uniformly heat many sizes of tubing or casing in an effort to meet the API standards consistently and also to produce, if possible, a product that was better than the standard set up by the API.

After considerable study and testing on the part of our pioneer customer and ourselves, we designed and built a continuous gradiation line to heat tubing continuously to be followed by a controlled quench, and immediately following the quench to pass the tubing through a tempering line. The first installation, the principles of which were conceived in 1945 and thoroughly checked, was built the latter part of 1946 and placed in operation in 1947. The tubular items produced in this pioneer line have been thoroughly tested and accepted by purchasers of oil country tubular products.

During the Association of Iron and Steel Engineers' Meetings in October 1952, Mr. F. H. Bremmer, of the Spang-Chalfant Division of the National Supply Co., presented a paper covering this early installation entitled "Continuous Heat Treatment Process Produces High Strength Oil Well Casing." This paper was later published in Iron and Steel Engineer issue of January 1953 and also appears in the AISE yearly proceedings for the year 1953.

Between the years of installation which was 1947 and presentation of the paper in 1952, approximately five years elapsed, in which time more than 80,000 tons or more than 7,000,000 ft of quenched and tempered casing had been produced. The paper revealed the superior product obtained and ability of this equipment to surpass the specifications of the American Petroleum Institute, using steels of lower alloy content than were previously considered practical.

An advertisement that appeared in the Wall Street Journal in 1952 placed there by our customer started out with a caption *"How to Save 300,000 lb of Molybdenum and 1,000,000 lb of Manganese."* The advertisement further stated the savings were made by heat treating carbon steel casing to give it high strength characteristics similar to those of alloy steel casings.

Specifications for what is known as N-80 product were met with H-40 chemistry steel. The H-40 chemistry is approximately 0.38 to 0.42 per cent carbon and 0.80 to 1.00 per cent manganese. The N-80 steel chemistry is 0.40 to 0.48 per cent carbon, manganese 1.20 to 1.60, and molybdenum 0.20 per cent.

Mr. MacGregor's paper emphasizes the pitch of the entrance and exit rolls which, on 7 in. pipe, would provide approximately one revolution per three foot of lineal travel. The same pitch on 10¾ in. pipe would provide one revolution for each five feet of lineal travel. Our early experience dictates that a more uniformly treated pipe and straighter pipe can be obtained if the revolutions per lineal foot of travel are increased. Our later installations provide three to four revolutions per lineal foot of travel for average size pipe, which is about 10 to 15 times more revolutions per foot of travel than the equipment described by Mr. MacGregor. We have found that by using more revolutions per foot of travel, a better end product is obtained in respect to straightness and it has also been ascertained that six points greater hardness can be achieved through faster rotation.

The point of rotation is of importance, not only because of the pipe straightness and uniform heating; but it is of vital importance as the tube passes into the quench. A uniform quench is just as important as a uniform method of heating. Our latest designs use fast rotation with a controlled forward movement in accordance with the pipe diameter and tube size. Adjustment for different size tubing is easily made at one control point. There is absolutely no need for extensive mechanical or electrical readjustment when changing from one pipe size to another. This is done by the operator within a matter of a couple of minutes.

It was recognized on the initial installation the pos-

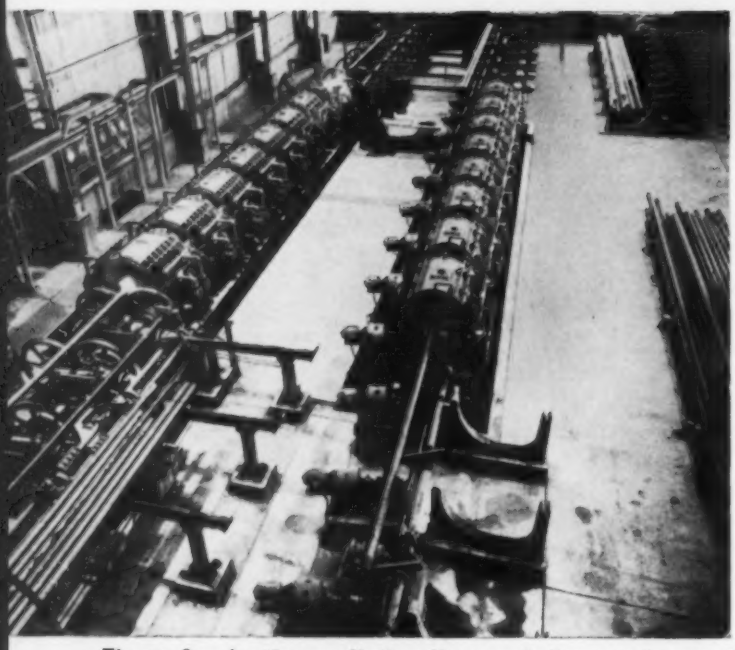


Figure 8 — In the gradiation line, each furnace is a unit which can be easily replaced.

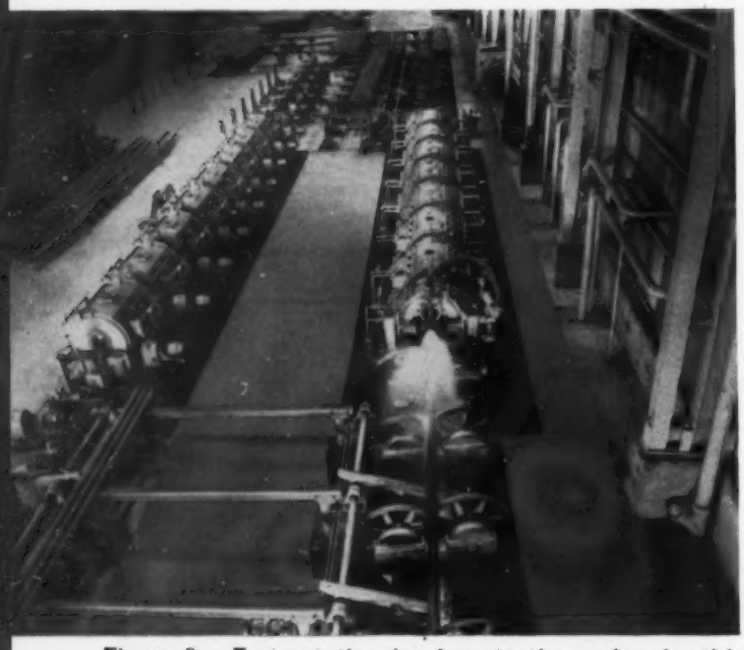


Figure 9 — Fast rotation is given to the casing in this type of line.

sible need for rotation and consideration was given to placing the rolls on an angle for two reasons.

1. Stresses in tube due to mill operation. Gradiation furnaces are of a construction that uses directed and controlled radiant transfer, with convection, around the entire circumference of the tube as the tube progresses through the line. In spite of the uniform heat transfer, we were sure rotation would help keep the tube straight as the mill stresses were relieved.
2. Need for adequate quench around entire circumference of pipe. Although quench was designed to provide a sharp line around the circumference, rotation was looked upon as an asset to water coverage, and prevent distortion at the point of quench.

The foregoing two reasons for rotation were logical thinking; but the installation was made without skewing the rolls. The desire was to try the furnace line without placing the rolls on an angle. It soon became evident that the original reasons for placing the rolls on an angle were fact, and the roll angle was incorporated in the line movement.

As our investigation proceeded, all later gradiation installations were designed with disc type conveyors for the quench line.

Figure 8 is a view of a complete line. Note each furnace is a unit easily replaced for maintenance. Using a multiplicity of furnaces, it is very easy to increase the production capacity of the line by installing more furnace units.

The conveyors between the furnaces are easily removed for any maintenance that may be necessary, avoiding the shut-down of the furnace line production for prolonged periods.

Please note this type of furnace with fast rotating conveyor provides a uniform, constant rotation as the tube progresses through the furnace line with absolutely no dwell time at any point of the short heating cycle.

Such lines heat at the rate of 7 to 8 min per in. of wall thickness to quench temperature.

The compact furnaces, in case of any shut-down caused by production curtailment, can be brought up to operating temperature within 30 to 60 minutes, which is not characteristic of large furnace structures.

Figure 9 shows another view of the high rotation discs and ring quench in action. It is easy to see the pleasing scale-free surface and the straightness of the tube. Mention is made of the use of more Btu's per ton in the gradiation equipment than is required by the furnace discussed in the paper.

Sometimes expressed Btu's per ton are confusing. What about start-up time after shut-down or Btu's to hold furnace at temperature during the week-end when mill production is usually stopped? According to our knowledge the high Btu value expressed in the paper may include holding at temperature during non-production periods and also fuel required to reheat after week-end shut-down. We have other average gas consumption data over weeks of operation on different size tubing on latest lines that are lower than the stated figure. Diameter and wall thickness of the tubing will greatly influence the Btu's per ton.

Suppose we consider $1.00 per thousand cu ft for 1000-Btu natural gas, you would be buying 1,000,000 Btu's for $1.00. Now $1.00 per thousand cu ft is a high rate for natural gas but it is a nice round figure to arrive at a point. If there were a saving of 1,000,000 Btu per ton of steel, the $1.00 per ton savings in heating costs is relatively minor in this high quality steel.

Our customers inform us a little higher fuel cost per ton is of very little concern because with the uniform, fast rate of heating under control, combined with accurate quench and fast rotation, the cost of straightening is practically eliminated.

In fact, we understand ton after ton is produced without straightening until some tubes come through that are highly stressed in the mill, which is a warning that adjustments are required at the mill.

F. S. Bloom: From Mr. MacGregor's remarks, we could be led to believe that the conveyor makes the furnace produce a uniformly heated pipe. I can agree with Mr. MacGregor that his conveyor is doing an excellent job, and the furnace company, who constructed this job, did everything possible to make this a tight furnace.

Nevertheless, this tube quenching job is tough. The tube must be kept straight. Uniform heating is a must.

In 1952, Fred Bremmer discussed this subject before the AISE, and led everyone to believe that the only way to get a uniformly heated tube was to:

1. Use barrel furnaces.
2. Provide fast rotation.
3. Heat from all sides.

This barrel furnace arrangement does not produce large tonnages without taking up lots of space. It is questionable whether J&L would have considered the walking beam furnaces had space been available for a line of barrel furnaces. Many operators thought that the walking beam furnace could not work; that the material would not be heated uniformly enough for the water quench.

Why has this furnace been so successful? In my opinion, there are a number of well-engineered factors that make this job work; namely,

1. A well-constructed tight furnace.
2. A good furnace conveyor mechanism.
3. An improved quench arrangement.
4. Improved combustion system.

The furnace structure and conveyor mechanism have been fully described. The combustion system needs a little more explanation to be fully understood. It is built around our tempered flame burner, and with this system, the combustion air flow through the burner is kept constant while the fuel input is varied by the control motor from furnace temperature measurement. This system is used on both the normalizing or high temperature furnace as well as the draw furnace. The combustion system is the same for both the high and low temperature heating furnaces.

The tempered flame combustion system, though it has been in use for at least ten years, is not too well understood. It operates on the principle that the flame temperature can be reduced by the use of excess air. Thus, it is possible to operate a heat treating furnace with flame temperatures only slightly above that of the furnace temperature. Another item which attributes to the success of the tempered flame system is that the burner velocity is practically constant. Thus, the entrainment of furnace gases by burner flame is a fixed amount, all of which leads to the production of a uniform furnace temperature, and is the best explanation we have for the unusually good results obtained from the J&L heat treating and draw furnaces.

It should be expected that with the use of large amounts of excess air to provide tempered flame, that the fuel efficiency of the process would be relatively low. However, this is not the case since the fuel results at J&L indicate that we can heat treat with a fuel usage in the neighborhood of 1,200,000 Btu per ton, which is as good as that obtained with any direct-fired burner system.

The most outstanding part of this J&L installation has been given very little publicity; namely, the job accomplished with the combustion system in direct firing the continuous draw furnaces. Every combustion engineer realizes that it is much easier to get temperature uniformity in the high temperature ranges while it is very difficult to get temperature uniformity with direct-fired furnaces in the low temperature ranges; namely, furnace temperatures under 1000 F. The draw furnace is an outstanding tempered flame job, and is accomplishing the same temperature uniformity that has been difficult to accomplish even with recirculating draw furnaces.

The J&L heat treating furnace and the draw furnace are two outstanding furnace installations and indicate what can be done when everything works properly; namely, furnace design, conveyor mechanism, and combustion system. To be sure, J&L has had some difficulties in producing straight pipe, but these difficulties have been no more than those encountered by others in attempting to produce this material by the barrel furnace process.

J&L should be commended for their fortitude in attempting to construct a process when past experience indicated so many difficulties. One of the main differences between the barrel type furnace and the walking beam furnace arrangement is the great difference between speed of rotation of the pipe in the barrel furnace as against that of the walking beam furnace. Of course, this has its effect on the ability to obtain uniform heating and uniform quenching. The rotation of the pipe in the quench head in the walking beam furnace is about one-tenth of the speed of rotation of that in the barrel furnace quench head.

I wonder if Mr. MacGregor has any good explanation for why he gets away with the slow rotation compared with the barrel installation.

J. J. B. Rutherford: As Mr. MacGregor has pointed out, oil country tubular goods have reached a limit for the conventional materials of the past. In drilling a deeper well, and where bottom-hole pressures up to 15,000 psi are encountered, it is no longer possible to heavy-up the wall because this seriously restricts the fluid-conveying characteristics. N-80 materials were developed about 1937 to meet such a situation and this grade now proves inadequate some fifteen years later, as evidenced by the demand for P-110 grade.

The highest strength steels have traditionally found application as tools, so that quenching and tempering pieces dimensioned in inches is readily accepted. Tubing is generally manufactured by conveying in a longitudinal direction, except for the cooling beds following the rotary piercing sequence of operations. Mr. MacGregor has effected a combination of the handling methods found in single-pass heating with in-line conveyor heating. Innovations of this type are bound to give rise to new problems which in turn are a challenge to further developments. Does this equipment effectively handle a non-uniform section such as a tube with upset ends? Are the ends of the tube uniform in temperature and quenching rate? Is allowance made for croppage? Is the furnace designed for ready change in fuel type? What allowance is made for scale accumula-

tion around the hearth and moving parts? These constitute hurdles to be cleared as progress develops.

James MacGregor: I did not intend in any way to disqualify the good work done by Mr. Kniveton's company, in cooperation with Mr. F. Bremmer of National Supply Co., in developing suitable equipment to satisfy the basic requirements for quench and temper operations.

The initial line to which I have referred, and as outlined in the paper submitted by Mr. Bremmer in 1953, had quite a variety of problems to be overcome and from the remarks, it appeared to be the consensus of opinion at the time, that unless something new and ingenious could be developed, the ultimate in dry heat treatment methods had been reached. The challenge of any engineer or engineering organization is the possibility of developing new equipment with new ideas to overcome basic problems of production, and simultaneously with that thinking, attempt to increase the output capacity in order to permit industry the opportunity of not only a maximum return from their investment, but to better meet the ever increasing demands for better grade products with an increased production and reduced operating costs. It was with these basic thoughts in mind that we developed the furnace now in operation at Aliquippa. I agree with Mr. Kniveton that our basic theoretical understandings of the operation itself, insofar as the heating of the product is concerned, vary quite broadly, however, we are apparently attaining the same end result of good product. The major variations of the two theories are our use of temper flame burners for the high heat and soaking zones, the time differentials of soaking the product after it has attained the desired temperature, and the percentage of rotation of the product desirable to attain the end result.

The skew of our entry and exit rollers was determined after a great deal of consideration. We had first given thought to the possibility of an adjustable skewed roller table, and in final discussions with the customer's engineering departments, it was decided to arrange the tables at a fixed skew of approximately 30 degrees, which has proven very satisfactory in the operation and has created no difficulty whatsoever in the handling of the product entering the hot zone of the furnace from ambient temperature.

The method of motivating the product through the furnace to keep it constantly rolling as it is transferred on the walking beam maintains the same uniformity of straightness of product that Mr. Kniveton feels must be done through the medium of a fast rotation.

Our theories further differ in that we feel the product should attain a longer period of soaking time to assure uniformity of heat prior to quenching. In discussions with Jones & Laughlin's operating department heads, we find that the product attains a definite uniform temperature throughout the product, prior to its delivery to the quenching station, which we are all aware is a necessity if straight product is to result from this phase of the operation. Mr. Kniveton has made a statement relative to the straightness of product coming from the quenching station to such an extent that it requires no straightening operations at all. We, ourselves, have never inspected a line where straightening is not a necessity if commercially straight product is to be attained. Of course, the straightener product coming from the quenching station minimizes the work effort required in the straighteners to result in commercially straight product.

The economical aspect of the furnace operation is just as important a factor of costs as any other. The basic economies resulting from the operation of the furnace described in my paper attributes itself to a fixed air input with temper flame burner, with a variation of the gas input to attain the desired temperature for normal operation. The fact that we have a completely sealed hearth affords operations the opportunity of a definite controlled temperature of their furnace and the variation of the gas input attributes to the economy of operation. In Mr. Kniveton's remarks, he refers to the cost differential per ton of product processed, and of course, this results in a dollar per ton, using Mr. Kniveton's figures; and if this were so, on the basis of 80,000 tons of product processed over a five-year period in the furnace installation to which he has referred, this could have resulted in an $80,000 additional profit to the customer.

I have recently checked with mill operations at Jones & Laughlin's Aliquippa Works, regarding the tonnage processed in our furnace since its installation. These figures, over a seventeen month period, amount to 118,700 tons in comparison with the 80,000 tons processed in the gradiation furnaces over a five-year period. as indicated by Mr. Kniveton. Jones & Laughlin is now averaging between 7000 and 8000 tons per month of quench and temper product. Now I wonder if Mr. Kniveton would be good enough to tell us what length of gradiation furnace it would take to satisfy the requirements of our Jones & Laughlin installation.

We have attempted to add into our design the increased capacity operations desirable to all producers, utilizing a basic standard furnace and thereby holding the floor area normally required to a minimum. We have recently developed and contemplate an installation of a similar type furnace at a capacity rate of 100 tons per hour for normalizing only. This prospective installation will normalize a variety of product sizes at mill operation capacities. These are the attributes we have attempted to explain in the paper of the feasibility of increased capacity operations, along dry heat methods of treating steel products and still utilizing something acceptable to the operating departments of industry itself.

Mr. Bloom has explained very extensively the operation of the temper flame combustion system which he designed for this installation and there is little or nothing that we can add to clarify the remarks that he has made. In regard to his question as to a good explanation of why we get away with a slow rotation of the product in the furnace, compared to the barrel installation, it is difficult to ascertain at the present time a definite summation of the success of the furnace. It would appear that it is an accumulation of all of the factors involved from the entry of the product to the hot zone through the high heat zone and into the soaking zone, and inasmuch as this is a comparatively new

installation, we have not had the opportunity to fully accumulate all of the data required to the same degree that Mr. Kniveton has had with his installation. We are, however, obtaining information as it becomes available from Jones & Laughlin, from which we will finally arrive at a basic conclusion of the reasons for the success of the slow rotation of the product in our furnace against the high speed rotation in the barrel type furnaces. Jones & Laughlin has been very cooperative about giving us information regarding the operation of the furnace equipment, to permit us the privilege of arriving at these basic conclusions, even to the extent of their present experimentation with the new API Specifications for N-150. I understand that the basic process has worked out quite favorably so far in this experimental work.

Our basic decision to skew the rollers as we did has proven quite satisfactory in rotating the product at a sufficient rate to permit it the opportunity of accumulating the heat from the hot zone of the furnace upon entry, preventing distortion of the product prior to delivery to the racks. As pointed out in my paper, this did give us a bit of concern during the time of design, for we were all aware of the impossibility of piercing a billet and coming out with a completely uniform section under present methods of seamless production. It is this basic disuniformity of section that creates the basic difficulties of distorted product when heating and quenching. The product attains all of its heat in the first few feet of the furnace and the slow, even rotation that we effect with our walking beam permits the product to receive that heat without distortion. We have followed the theory that the product should have a certain cycle of soaking to insure uniformity of temperature prior to entry into the quenching station, and it would appear again that it is the accumulation of these facts that have made our furnace the success that it is, even though it reverses the basic ideas first developed in the initial installation referred to by Mr. Kniveton.

Incidentally, we are presently building a piece of equipment which, if it is successful, will have a greater control of the eccentricity of the wall during the initial piercing operation in producing seamless products. Should this piece of equipment do what is intended, it will greatly alleviate the problem of distortion created from this abnormality of production which has been accepted a part of the practice for so many years.

Mr. Rutherford has asked several questions which are not too difficult to answer. The first question was relative to the equipment handling a non-uniform section, such as a tube with upset ends. Before delivering this paper, we checked with Jones & Laughlin to see to what degree they had been handling upset ends in the furnace, and find they are normalizing 2⅜-in. upset pipe with the same success they are achieving with plain end product. We also inquired as to the quenching of upset product and they have made experimental runs in this particular phase of operation, which apparently have proven successful. However, I do not believe they are, at the present time in their production schedules, operating a quench and temper operation with upset pipe.

The second question of Mr. Rutherford's refers to the ends of the tube having a uniform temperature and according to the facts that had been made available by Jones & Laughlin, they are definitely obtaining a thoroughly uniform heat throughout the entire length of product, including the upset ends.

The third question of Mr. Rutherford's pertains to allowance made for croppage. If we are talking plain ends of seamless product, it has usually been found standard practice to crop the end of the product to prevent the possibility of cracks from the ragged end created in initial piercing from working into the body of the product proper, and this croppage is done at the finishing end of the line at the cutoff, facing and threading machines. So far as upset pipe is concerned, there would be no croppage involved; it would be purely a matter of facing the end of the upset prior to threading.

The fourth question of Mr. Rutherford's is whether or not the furnace is designed for a ready change in type of fuel. The furnaces, as they were installed at Aliquippa, have a combination burner suitable for both coke oven gas or oil and can readily be changed over from one to the other if deemed desirable.

The next question that Mr. Rutherford has was in regard to the allowance made in our design for scale accumulation around the hearth in moving parts of the furnace equipment proper. Due to the gentle handling of the product throughout the entire operation, there is little or no scale accumulation of any great degree over the entire hearth area. The only spot where we have noticed scale accumulation at all has been at a flag switch located at the runout side of the furnace adjacent to the quenching station, and the product rotating as it does entering the quenching operation creates sufficient friction on the flag switch to tend to peel a percentage of the scale from the product and this is the only point where it accumulates. This is readily cleaned out through the furnace door at the runout side of the furnace.

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ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

By HAROLD S. SILVER, General Patent Attorney, Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

PATENTS AND THE ENGINEER

. . . . knowledge of patents and patent procedure can be of great value to most engineers . . . . the patent system functions primarily for the benefit of society, particularly in the stimulation of new ideas and not particularly for the benefit of the inventor . . . . as a result the royalty system has developed through which returns are proportional to the amount of use made of the patent . . . .

▲ WHY should an engineer need to know about patents? Why not teach about patents just to the lawyers or law students as they presently do in most colleges and universities? It seems to some of us that Congress relies upon the politicians for knowledge of patents relating to atomic energy matters. Why bother engineers with specialized lawyer talk in an almost foreign language?

For just one reason. Industrial protection in general and the United States patent system in particular affects daily engineering problems and their solution.

How? Well, as a quick prelude, let us take a short look at history. Some 2000 years ago there was little interchange of ideas. There were no engineering publications, no meetings, no annual conventions. Means of communication was unsatisfactory and know-how in the arts and crafts was handed down by word of mouth from father to son and from master to apprentice.

The ruling monarch of the day needed income and so reserved to the crown certain monopolies. For example, the early Egyptian rulers retained brick making as a crown monopoly. It was accepted practice to insure royal income and military help for the sovereign, by the giving of titles, lands or other monopolies to those able to supply the royal needs.

New ideas were rare in these days. Men would not take the trouble to improve the methods of work and to pass their knowledge on to others unless they expected to gain material advantage. Much of the manufacture was performed by slave labor. The artisans and craftsmen though highly skilled were mostly uneducated people.

However, the wise old rulers knew the economic value of improving the lot of the people. When the people were comfortable, safe from the forces of nature; when food was more abundant; when better tools cut down back-breaking toil and provided more safety, the people prospered, were happy, and paid their taxes. The rulers realized that creative thinking was the basic ingredient for improved products and methods that would promote the progress of the useful arts.

So inducements in the form of money, estates, titles, appointments, decorations, etc., were given to local inventors to stimulate creative thinking. These inducements were also extended to outsiders to bring their arts and crafts into the country.

However, these inducements were not entirely satisfactory, especially from the standpoint of the ruling monarch. They were costly; they aroused jealousy and discontent in that the awards were made to spurious as well as genuine inventors. They did not differentiate between creative thinking that had no practical result and creative thinking that promoted the progress of the useful arts.

So they figured out a new solution, the granting of a limited monopoly to exploit the manufacture and sale of a product. Such monopoly cost the monarch nothing and it avoided rewards for faked or useless ideas and provided incentive to idea men to continue their efforts.

In the year 1421 in Florence, Italy, a grant in the form of open letters (literae patentes) to the general public was given to one Filippo Brunelleschi for some machine or kind of ship. The patent (as it was called) included a clause whereby all others were forbidden to use any other new means of river transportation "except such ship or machine or instrument as they may have used until now for similar operations." The patentee reserved the right to utilize newly invented or newly shaped machines. The patent was only good for three years, and the merchandise transported on the patented means was declared exempt from possible new impost taxes.

In 1474 a patent act was passed in the City of Venice which may have been the father of all patent laws. It had the following preamble:

> "WE HAVE among us men of great genius, apt to invent and discover ingenious devices; and in view of the grandeur and virtue of our city, more such men come to us every day from divers parts. Now, if provision were made for the works and devices discovered by such persons, so that others who may see them could not build them and take the inventor's honor away, more men would then

apply their genius, would discover, and would build devices of great utility and benefit to our commonwealth."

The act went on to state that every person building a new and ingenious device not previously made in Venice shall give notice when it has been "reduced to perfection so that it can be used and operated." All others were forbidden to make any similar device for a term of ten years or be subject to pay the inventor one hundred ducats and the infringing device to be destroyed. However, it is of interest to note that the Government was permitted to take and use the device in its activities but with the condition that no one but the author should operate it.

The grant of monopolies for other than new inventions became so onerous that in England in 1683 the Statute of Monopolies was enacted which limited the grant of monopolies by the crown to monopolies for exploiting new inventions.

By granting a patent right in the nature of a limited monopoly, an incentive for creative thinking was provided that functioned only if the improved method or product was commercially satisfactory. Obviously it cost the Government or taxpayers nothing to grant a right to prevent others from making a valueless product, for no one desires to make a valueless product.

Now how does this part of our economic system directly affect the engineer and his daily problems, and this refers especially to the engineer who like most of us has, in a sense, sold his patent birthright for a mess of salary checks.

This is a competitive age. The success of any company is dependent upon its maintaining a favorable competitive position. This necessitates the production of quality products affording some real sales advantage, such as lower price, better performance, greater utility, longer life, etc. Maintaining this sales advantage requires engineers who can creatively think of ideas that will provide cost reduction, product improvement and the development of new products. The expense of such engineering effort cannot be recovered if competitors are free to adopt the improvement. The adopting competitor not being burdened with development costs can readily under sell the company producing the improved product.

The patent system does in fact stimulate or induce such ideas. Thomas Jefferson who has been called the father of our patent system said, "The issue of patents for new discoveries has given a spring to invention beyond my conception."

A visiting Swiss said in 1876 in an address to his countrymen upon his return, "I am satisfied from my knowledge that no people has ever made in so short a time so many useful inventions as the American."

Abraham Lincoln said, "The patent system added the fuel of interest to the fire of genius."

The writer of a New York Times editorial said in 1908, "Yankee ingenuity became a byword the world over because of patent laws of unprecedented liberality."

F. D. Roosevelt said of our patent system that it "has promoted countless applications of the arts and sciences to the needs and well being of our people."

William R. Ballard said, "The patent law is a plan for harnessing the horsepower of man's self-interest to the cart of public benefit."

Dr. Karl Compton said of our patent system, "The patent system itself is fundamentally one of the greatest social inventions which has been made for the benefit of the human race."

The patent system does function to stimulate an engineer to creatively think. Patents provide a source of technological literature. Here is a tool not always easily available to the engineer. Many of the patented structures were not commercially successful. Although some are ancient history, some were born 30 years too soon and are perhaps still 10 years ahead of their time. In any event, here is a library of technology each element of which involved some degree of creative thinking. It is available for engineering education to provide a background for further creative thinking.

The patent system does function to stimulate creative thinking that results in a new and improved product. An engineer being a professional man particularly enjoys the respect of his fellowman. The public recognition of professional talent provided by the grant of a patent is great reward in itself. I quote from a recent letter acknowledging an award check sent by our company to an inventor:

> "Certainly the check is appreciated and will be put to good use. However, the self satisfaction of having my name coupled with an invention is the greater reward."

An inventor's name is conspicuously displayed on each patent. Many successful engineers have numerous patents to their credit, which indicates that it pays to publicize achievements.

Unless the new product is commercially desirable, the patenting of the invention and preventing others from making and using it, is an empty right. The corollary is: the patent system functions to stimulate development of improved products that are commerially desirable. There is no financial return to a company for a commercially unsatisfactory product and the development of such product is no basis for promotion and added pay.

It is of interest in passing to note that patent systems were not the result of demands by the rank and file in the engineer's union for a guaranteed annual return from their inventions. Instead these patent systems resulted from desire on the part of rulers (governments) to improve the economic standard of the people in the particular country.

We would like to recap the reasons why from the standpoint of the public good the granting of the "exclusive right" to make, use and sell for a limited period is so much more advantageous than the giving of lands, titles or money awards, that we marvel at the wisdom of the founding fathers in so forming our constitution.

1. The reward for an invention is closely related in size to the inventor's contribution of the public good. The public will pay well for an invention of great value and little for an invention of small value.

2. Payment for the invention does not bite into tax money. Even the costs of obtaining a patent are borne by the inventor.

3. The fact that the payment time is limited prevents continued payment long after the invention has in fact been paid for.

4. The fact that the right is exclusive permits recovery of development money without which recovery it would be difficult to obtain financing for development purposes, for others could immediately under sell.

5. Although it seems an anomaly, the patentee's exclusive right induces beneficial competition. When one company improves its product it makes it more easily salable. A competing company must find some way to regain any lost selling advantage. As the competing company cannot copy the patented improvement, he must of necessity find some improvement of his own that will make his product more commercially satisfactory. This is the kind of competition that promotes the progress of the useful arts.

6. A patent right spurs business enterprise for in order to be valuable the patented contribution must get into the arteries of commerce before the exclusive right has terminated.

But to answer specifically the earlier questions.

Why should the engineer starting on the drafting board know about the patent system?

Because it is an engineering tool that he may use—and the more he uses it the more valuable he will become—to himself, to his company and to his fellowman.

Why should the accomplished engineer, one who has arrived in his chosen profession, be conversant with the operation of the patent system?

It will teach him that although there are payments for inventions that are both stimulating and rewarding, the inventor's share is merely the by-product and not the basic result sought by the patent system.

It will teach him, nonetheless, that great rewards are available both in fame and fortune if the embodiment of his invention has great commercial desirability.

It will stimulate him to think creatively.

It will permit him a bit of immortality when his creative thinking actually promotes the progress of the useful arts. Not only has he done something specific that will provide better living for some part of society—but in so doing he has stimulated others to do their bit in raising the standard of living.

Why should the engineer in charge of a group of 25 young engineers need to know the seeming intricacies of our patent system?

Perhaps he has been professionally satisfied and, as an engineer, needs no further advance in the engineering spotlight. But his ability as leader of the group will stem from the commercially desirable products resulting from the creative thinking in his group. How better apply stimulus to such creative thinking than by means of the patent system. There is no doubt that knowledge of an interest in the patent system on the part of the engineer in charge will help to stimulate the creative ability of the group. The engineer in charge has a great opportunity to teach the values of the patent system.

The vice president in charge of engineering has a great opportunity to make the patent system function for the public good in general and the good of his company in particular. Where his philosophy is one that encourages creative thinking—the patent system has a real opportunity to induce the right kind of practices that result in the right kind of creative thinking.

Where his attitude is one that suggests patents are either a necessary or unnecessary evil, you will usually find a minimum of commercially desirable improvement.

His opinion may be sought at high professional levels, perhaps even by engineering educators as to curricula. And heaven knows the engineering student needs to be taught about the United States patent system and its function as an engineering and economic factor, far more than law students need to be taught patent law.

His opinion may even be sought by legislators on the question of giving or withholding the benefits of the patent system from a large section of industry that needs great peace time stimulus and expansion, the atomic energy field. If he is convinced that the patent system is an inducement to commercially desirable development, he may help this country to be in the lead in that area, rather than drift behind.

The United States patent system is presently being pulled apart by several more or less disinterested groups in order to see what makes it work and whether it works in the public good. One of these groups is the Patent, Trade-Mark and Copyright Foundation of George Washington University Law School, Washington, D. C. The results of a study by competent people who are not biased toward government, toward industry or toward the patent bar should be very enlightening. It is a non-profit group and if you are asked and can help, it will be in a good cause.

DISCUSSION

PRESENTED BY

WALTER L. KEENE, Director of Research, Superior Steel Corp., Carnegie, Pa.

J. T. HARMUTH, Mechanical Engineer, Continental Foundry and Machine Co., Pittsburgh, Pa.

HAROLD S. SILVER, General Patent Attorney, Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

W. N. JOHNSON, Ingersoll-Rand Co., Pittsburgh, Pa.

M. E. FREDERICK, Patent Attorney, Ordnance Research Laboratory, Penn State University, University Park, Pa.

ARTHUR A. ARCHER, Engineer, Mosebach Electric & Supply Co., Pittsburgh, Pa.

J. D. EVANS, Assistant Patent Engineer, United States Steel Corp., Pittsburgh, Pa.

Walter L. Keene: I would like to ask the advisability of taking out patents in foreign countries, such as Germany, France, Russia, and so forth; are they any good in some of these countries? Are they worth it?

Harold S. Silver: This matter of patents in foreign countries causes considerable worry. The United States and Canada are two of the few countries who do not have payments after issuance of taxes, as do most all

other foreign countries. In Germany taxes on a patent, if paid to the end of the patent period, may cost about $2,000. In various countries it is varying amounts, usually increasing as the time goes on. So foreign patents are a costly matter.

We have found in our own company that unless we are either going to license someone under the foreign patent; unless we are going to manufacture ourselves in the foreign country; or unless the matter is of transcendental importance, foreign patenting is not worthwhile.

Walter L. Keene: A further question: Would it be advisable to apply for a patent in Russia?

Harold S. Silver: I know nothing whatsoever about the Russian patent system and we have filed no patent applications in Russia.

J. T. Harmuth: I would like to ask Mr. Silver about a feature of the new patent law which allows an old patent to be renewed for new uses at the present time. I understand there is such a feature in the new patent law.

Harold S. Silver: I think perhaps you are referring to a part of the new law which says that a patent may be granted for a new use of an old device, or an old process.

I think one of the best examples of that was when a certain material that had been known for many years to be a good fire extinguisher was found years later to be a very excellent insecticide. That was contended to be patentable. Because it was exactly the same product that had been made before and because there was no invention in the process of using it, it was held to be unpatentable as an insecticide because it had been known as a composition of matter, as a fire extinguisher.

The new law was designed to permit such a new use of old material to be subject of patent. Does that answer your question?

Member: I want to inquire about the status of a device developed by an operator, an employe who is employed not for the development of new ideas but, say, for operation and develops a patentable idea. Does it belong to the company or does it belong to the employe, or does it belong in part to each? That is an old subject, but will you comment on it?

Harold S. Silver: There are a lot of ifs and buts and ands about that one, and it could be argued several ways.

There is no doubt that if a man is hired to invent, even though he does not have a written contract to that effect, his invention that he is hired to make belongs to his employer. You run into various questions of fact when you get away from that, when you get to a man that is not hired to invent.

If you want my opinion as to desirable policy, it would be that the employer have a written contract with those employes: (1) who may be hired to invent, (2) who may reasonably be expected to invent, or, (3) who have access to confidential material such as would bring them problems and possible solutions that they would only have by reason of their employment.

To contrast that, let me say that if an invention is made by a man who sweeps the floor, even though you had a written contract with him, it might be very desirable for you to purchase that invention from him in some manner or another. If you had a legal, binding agreement, it would not be necessary. I think better policy dictates that when you have inventions made by other than the groups I mentioned, you pay for the invention.

W. N. Johnson: I wonder if there is any general pattern in this country as to prosecution on patent infringements? In other words, there is the inducement to have a patent or create a patent; what is the deterrent to not steal someone else's?

Harold S. Silver: The courts are open for any infringement suit. I understand in New York it may take as long as two years before a suit gets to trial in the Federal Courts and with the present number of Federal judges. Appointments of judgeships sometime depends upon political expediency; we have had a vacancy in Wisconsin for a year and a half, and because some people cannot get together on the appointment, we still do not have our needed judge.

But the deterrent would be payment for the infringement. If it has to be a court battle, you have to go through the various difficulties and the pain of going through the suit. But the deterrent to infringement is the cost that it may be to you in case you lose the legal battle.

M. E. Frederick: I wonder if you could tell me what type of information your company considers worthy of documentation from a patent standpoint?

Harold S. Silver: The answer to that question depends on the person you are speaking to. Some of our competitors say we patent everything under the sun, no matter how small. Some of our own engineers tell us that we do not patent even half the million dollar ideas that they submit.

We find in our company, which is divided about into two parts the tractor division, in which we are liable to make 20,000 of one product each year, and the general machinery group where we may only make one or two or three items a year, that we have a little different practice in the one area than the other.

In the tractor area, we seldom patent anything that has not gone into actual commercial use. In our general machinery division, there may be some inventions made for which they are waiting, five, six, eight, or ten years for a customer to try them out. Those we might go ahead and patent before they go into commercial use.

Arthur A. Archer: The question of reduction to practice has been discussed quite a bit. I have seen what appeared to be patentable ideas that those skilled in the art would recognize immediately would be of great value in operation. Yet they have not been reduced to practice. And in one case the fellow lost it, because it would cost management large sums of money to actually demonstrate it. Yet those possessing knowledge of the situation, recognized at a glance that it was of great value.

Harold S. Silver: That brings up an important factor, and that is that the patent system is designed primarily for the public good and not for the inventor's good. Hence an invention that is made—and I use the term loosely there, not in the technical sense, but has been

conceived, sketched out, and thought through on the part of the inventor, if he puts that in his desk drawer, no one ever sees it and it never gets out, it does the public no good, and it has not served its purpose in the patent system.

You speak of reduction to practice. There are many inventions which by their nature you must wait for an opportunity to put them into a full size embodiment and actually try them out to see whether they successfully operate. That is why the filing of a patent application is called in the technical sense and in the patent attorney's parlance, a constructive reduction to practice. So if you have an invention that you are not able to actually reduce to practice and you file a patent application in the United States Patent Office covering it, you will, as far as saving your patent rights are concerned, have constructively reduced it to practice.

Walter L. Keene: It has often been said that in the United States a patent is an "invitation to suit" until it has gone through a court. Whereas it is said in Germany a patent is not granted until the patent is investigated very thoroughly. Is that true?

Harold S. Silver: Both Germany and the United States have the same system as to examination, as to novelty, as to patentability, and invention. There is no guarantee whatsoever by the United States Patent Office when a patent has been granted that it is a usable invention. As to whether the patent will stand up in court, it has the presumption of validity when it comes out of the Patent Office. While it has been said that a patent is an invitation to a suit, it is another matter of providing that basic factor that, if you have not made an invention that is useful and worthwhile commercially, it will not stand up under the fire that it has to in order to be a part of the inducement to further creative thinking and promotion of the progress of the useful arts.

Member: Patents sometimes cover 20 features. Is it possible to use two of those features in another patent without infringing on the patent?

Harold S. Silver: If a patent is granted for a combination of elements, then in order to infringe you would have to use that combination, not any one of the elements, because you might have a new combination with four old elements and one new one. Or you might even have a combination of elements where you had five old elements when coacted in a new way to get a new or better result. So using two of the old elements would not in any way infringe a patent covering an entire combination. But you may have patents which will have claims to a combination and a subcombination and perhaps some subcombination of the subcombination. So you have to be careful.

J. D. Evans: I wonder if you would discuss the subject of who is the inventor? We often have that problem come up. Supposing a chief engineer gives an order to develop a certain thing, he just states the problem, he gives it to the designers and, "Here it is, here's the problem." Now the designer comes up with a workable design. Who is the inventor?

Harold S. Silver: That is one that can take a lot of discussion. Who is the father of the child is often very difficult to determine. Especially so when each person thinks his own brainchild is not only worth a million dollars but it is the product of his own brain. So there are a number of technical rules by which we go by which the Patent Office rules. It has to be, because unless a patent is applied for in the name of the inventor it is not a valid patent, and so it is very necessary for us to know who is the inventor.

I could answer simply that if the invention was in giving the problem and if the working out of the design was merely what any draftsman could do, then the invention is made by the man giving the problem. If the problem is merely one that anybody knows, but the invention comes in the manner in which the design is brought to a finished result, then of course the invention is in the design.

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BUFFALO SECTION

Tuesday, June 5, 1956

Fifth Annual Golf Meet.

Orchard Park Country Club.

CHICAGO SECTION

Tuesday, June 5, 1956

Golf Party.

Gary Country Club.

DETROIT SECTION

Saturday, June 9, 1956

Summer Party — Dinner and Dance.

Detroit Yacht Club, Belle Isle.

PITTSBURGH SECTION

Monday, June 4, 1956

Golf Party.

South Hills Country Club, Pittsburgh, Pa.

YOUNGSTOWN SECTION

Monday, May 28, 1956 — Tour 4:00 P.M., Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

Tour: New Continuous Galvanizing Line and Finishing Facilities at Republic Steel Corp., Warren, Ohio.

Speaker at Meeting: A. F. Prust, Assistant Chief Metallurgist, Republic Steel Corp., **"The New Continuous Galvanizing Line at Republic Steel."**

Mahoning Country Club, Girard, Ohio.

Wednesday, June 20, 1956

Golf Party.

Tippecanoe Country Club, Youngstown, Ohio.

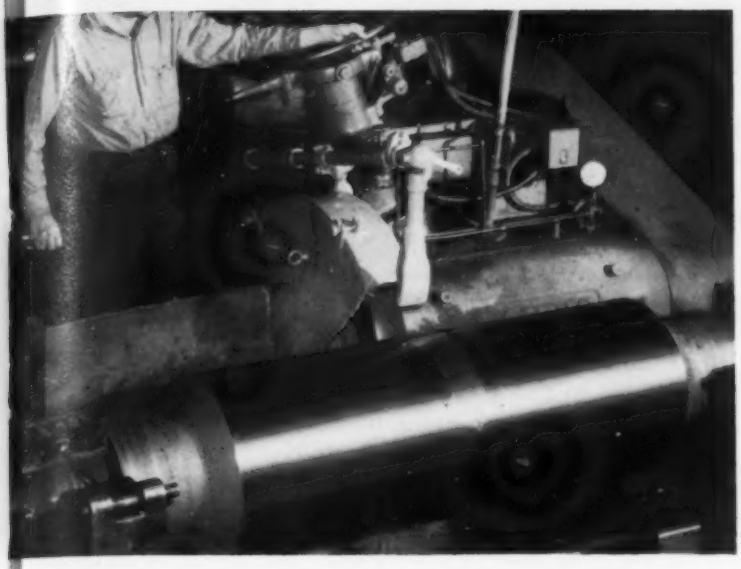

Figure 1 — Experienced operators are a big factor in obtaining good grinding results.

Roll grinding and roll grinding wheel application

By WILLIAM POPE
National Grinding Wheel Co., Inc.
North Tonawanda, N. Y.

Roll grinding machines are large powerful cylindrical units of sturdy construction to give minimum variation when grinding . . . . equipment is important, since the finished product can be no better than the rolls from which the product is rolled . . . .

▲ ROLL-GRINDING is a specialized form of cylindrical grinding requiring considerable skill since it is precision grinding of a high caliber. Unless rolls are accurately ground, it is impossible to produce rolled steel strip or aluminum sheet of the required quality. The finish on the rolled material can never be better than the surface of the roll itself, and unless the roll is ground accurately with respect to straightness (or crown), the gage of the metal being rolled will not be uniform. The present day trend in roll-grinding is toward still closer dimensional tolerances and higher finishes; requirements that challenge the wheel manufacturer, the machine builder, and the machine operator. Without the skill of the operator, no grinding wheel will produce desired results, while on the other hand, without the right wheel, an operator, no matter how skilled will have trouble. It can truly be said that the best grinding wheel made is of little value when it is being used on the wrong job or application. This is true in spite of the fact that diverse cutting characteristics can be given a wheel by skillful manipulation, with relative speeds of work, wheel and traverse. In other words, a skillful operator can, by manipulation of controllable factors, compensate to a degree for deficiency in wheel size and grade.

THE ROLL-GRINDING MACHINE

Roll-grinding machines are basically large powerful, cylindrical grinding machines of very sturdy construction to insure minimum vibration, when grinding. In this country we have six different make roll-grinding machines, namely: Mesta, Landis, Farrel-Birmingham, Cincinnati, Norton, and Lobdell. In addition to these, a few of the foreign made roll-grinders are in use here as well as in Canada and Mexico. The most popular foreign made machine is the Waldrich-Siegen roll-grinder, which is made in Germany.

Conventional roll-grinding machines range in size from 10 to 60 in.; this dimension designating the maximum outside diameter of the work it will accommodate. The medium and large size machines are commonly used in steel and aluminum plants. They are the 28, 36, 48, and 60-in. grinding machines. These machines generally use a 30 x 3 in. or a 36 x 4 in. grinding wheel and are equipped with an effective filtering device in the coolant system. Rolls are generally ground by supporting them on their necks and journal rests may be either brass, cast-iron, or babbit; the latter provides a cooler bearing with less tendency to score the necks than brass or iron. The roll drive is generally of the universal type to insure uninterrupted and smooth rotation. Most roll-grinding machines are designed so that the wheel traverse, wheel speed and roll speed can be varied and the skilled operator regulates each to obtain the best grinding results. Most present-day machines are supplied with ammeters to which the operator can refer to obtain the highest rate of production possible, and learn at what point the wheel is

working at its maximum efficiency. A crowning mechanism is an important feature of the conventional roll-grinder, because it is necessary to crown many of the rolls used in steel mills, aluminum mill, and paper mills. This attachment makes it possible to grind rolls either with a crown or concave. To withstand the high stresses set up when grinding, it is essential that the machines are of heavy construction and are equipped with a generous size wheel spindle bearing and motors. Many of our roll-grinding problems today are due to the fact that the equipment being used is too light for the work. In other words, it is always better to have the elephant do the donkey's work than vice-versa. For example, a 36-in. grinder is far superior to a 28-in. grinder when grinding 25-in. diam hot mill work rolls, where an average of 0.030-in. stock removal is required. In this instance, the larger machine will do at least 25 per cent more work with less effort, for the simple reason that the larger machine is more rigid and has the size wheel spindle and power to break-down the wheel when applying heavy feeds. The initial cost of roll-grinding machines and the high quality work they must produce makes it imperative that they be kept in A-1 condition mechanically at all times.

THE ROLL-GRINDING WHEEL

The cutting action of a wheel depends upon: (1) the kind of abrasive; (2) the size of the abrasive grains; (3) the bond which holds the abrasive grains together; (4) the spacing of the grains in the bond, or the structure. For uniform and dependable cutting action, the abrasive grains must be of controlled size and uniformly distributed throughout the wheel. These grains are held together by one of three bonds, namely: resinoid (synthetic resin), vitrified or ceramic, and shellac. The strength with which the bond holds the grain is known as the grade or the hardness of the wheel and can be varied through wide limits. Note that the hardness of the wheel does not relate to the hardness of either the abrasive or the bond, but only to the resistance of the bond offers against letting the abrasive be torn out of the wheel. Structure is the relationship of abrasive grains to bonding material, and grinding wheels can be made dense or open to suit grinding conditions. Grain sizes run from 10 to 600 and wheel diameters from 14 to 36 in. and 2 to 6 in. in width. The grinding wheel is in theory, and to some degree in practice, self-sharpening. Grains fracture and present new cutting edges or when dulled and badly worn down, they are torn out of their setting and so allow other grains to come into play. When an abrasive grain starts to enter and penetrate the work as the wheel and work revolve, the depth of the cut gradually increases to a maximum somewhere along the arc of contact, and since the wheel usually rotates much faster than the roll, the greatest depth of cut is very near the spot where the wheel leaves the work. In hard materials, too large a grain size causes burning or glazing.

Wheel makers must have the closest possible control over their raw materials and processes, so that once a user has found the grinding wheel best suited to his particular job, it is essential he be able to get a wheel of the same properties on re-order; and make sure that every wheel will perform the same on a corresponding application.

ROLL MATERIAL AND QUALITY OF SURFACE AND FINISH REQUIRED ON HOT STRIP AND COLD STRIP MILL ROLLS

Hot strip mill working rolls, so called because they are used for rolling hot steel in strip mills, are invariably made of nickel grain or a nickel chill casting. The size of the work rolls vary from 12 to 30 in. in diameter and from 24 to 132 in. in length. Alloy content is generally chrome, nickel, and molybdenum, and shore hardness of bodies run from 70 to 84 scleroscope. These rolls require a good commercial finish which can generally be accomplished with a 36 to 46 grain silicon carbide, resinoid bond wheel. In reconditioning these rolls for the mill, average stock removal runs from 0.015 in. in the finishing stand to 0.040 in. in the early stands. In order to obtain a sheet of equal gage and thickness throughout its width, the top roll is crowned by means of a crowning device in the roll-grinding machine, to compensate for the deflection of the roll caused by the tremendous rolling pressures. These crowns vary, depending upon the gage and width of strip rolled and range from 0.005 to 0.025 in. in diameter. Surface and finish requirements vary somewhat in different mills, depending upon the material to be rolled and standards set up in individual plants. Inasmuch as most of the product from the hot strip mill is usually rerolled to a finished gage on the cold strip mills, a good commercial finish meets the requirements, and as previously stated, a 36 or 46 grain wheel is satisfactory for grinding hot strip mill working rolls. If the correct grade wheel is used, very little wheel dressing is required.

Hot strip mill back-up rolls are either cast alloy steel or forged steel, with shore hardness from 48 to 58 scleroscope on the cast roll and from 60 to 80 scleroscope on the forged sleeve rolls. Back-up rolls are up to 60 in. in diameter and up to 130 in. in length. These rolls are usually ground with a 24 to 40 grain aluminum oxide, resinoid bond wheel. It is essential that the back-up rolls are accurately ground and checked for straightness and out of round in order to avoid rolling troubles in the mill.

The majority of cold strip mill working rolls are made of forged steel; however, some cast nickel grain and nickel chill work rolls are used on the tandem and skin mills. The forged hardened steel work rolls are 97 to 102 scleroscope, while the shore hardness of the cast rolls runs from 86 to 90 scleroscope. Cold mill, cluster-mill, and skin mill working rolls vary in size from 2 to 30 in. in diameter and from 16 to 96 in. in length. Cold reduction is performed to reduce the strip thickness, to improve the surface and to alter the characteristics of the steel. Inasmuch as the material is reduced to its finished gage during the cold rolling operation and takes its final finish from the rolls, it is obvious that these rolls must be ground with dimensional and surface accuracy. For the average run of cold mill work rolls, the finish produced with 80 to 150 grain wheels is

considered satisfactory. Generally speaking, resinoid and shellac bond wheels are preferred in grinding cold mill rolls. Vitrified wheels are a minor factor, and when found are in 80 to 100 grit. Cold mill roll surfaces must be free from chatter and scratches, feed lines, diamond dressing tool marks, and other surface imperfections must be eliminated. Forged steel tandem mill work rolls are usually ground with 80 grain aluminum-oxide resinoid bond wheels. However, 80, 120, and 150 grain shellac bond wheels are being used to good advantage on temper mill and skin mill working rolls, as well as on the tandem mill finishing stand. On these applications, the average grinder operator prefers a good shellac bond wheel; it stays sharp and free-cutting and produces the desired finish in less time and effort, because it is easier to work and does not produce chatter as readily as a resin bond wheel, under the same conditions.

ROLL-GRINDING FLUIDS AND GRINDING COMPOUNDS

The purpose of grinding fluids are:

1. To keep the temperature of the work as uniform as possible and prevent extreme localized heating.
2. To reduce friction between the wheel and the work and to lower the resistance of the metal to the action of the abrasive.
3. To retard loading of the wheel face.
4. To assist the wheel in producing the type finish desired.

After trying many different kinds of grinding fluids over a period of years, we found that they are all a necessary evil as far as roll-grinding is concerned. Plain water is the best possible coolant, but it rusts the work and the machine parts. To prevent this, we used crystal sal-soda and found this to be superior to all other types of grinding compounds used for roll-grinding. Soluble oil type grinding fluids should not be used with hard water since they adversely effect the cutting action of the wheel and cause the face of the wheel to glaze. Strong alkali solutions should not be used with shellac or resin bonded wheels, as they will attack the bond. Soap solutions are good coolants, technically, but they tend to foam and cover the work to the point where the operator is handicapped. The many grinding fluids on the market have merit and are almost indispensable for centerless, surface and internal grinding. However, on roll-grinding (except as an aid to produce certain finishes) we preferred crystal sal-soda to all other grinding compounds.

WHEEL TRUEING AND DRESSING

A grinding wheel is trued or dressed in order to restore its cutting face, so that it will produce perfectly round and smooth work. Wheel dressing is an important phase of roll-grinding insofar as finish requirements and production is concerned. The dressing tool removes the outside layer of dulled abrasive grains and any metal that the wheel may have picked up, so that new and sharp grains are presented to the work. In this respect, dressing may be considered a sharpening operation. Grinding wheels are usually self-sharpening, but dressing is occasionally required so that the wheel will be fast cutting continuously. For precision grinding, where accuracy and high finish are required, the industrial diamond is still the most popular dressing device, although mechanical dressers are often used on coarse grain wheels used for rough-grinding. When dressing 30 and 36-in. diam wheels, a 2½ to 3½ carat diamond proved the most economical and these were reset at least three times before they wore out. A fast traverse produces a free cutting wheel, while a slow traverse favors a high finish. A generous flow of coolant should be used to wash away the particles of abrasive and bond and to prevent the over-heating of the diamond. The diamond should be turned often to prevent a sharp edge. Frequently a flat spot on the diamond causes it to crack from excess friction heat, which is all the more reason why it should be watched and turned often. It is essential that the trueing tool be set so its center line is slightly below that of the wheel, and is at an angle of 10 to 15 degrees to it, pointing down in the direction of the wheel travel. In other words, the diamond must "drag" on the wheel with light cuts not exceeding 0.001 in. per pass. As stated before, it is important that the diamond is turned on its axis from time to time to present a new sharp edge and allow the diamond to sharpen itself. Failure to support the tool solidly with the least possible overhang, leads to gouging, chatter marks, diamond marks, and even breakage. Wheel dressing can be held to a minimum by using the right grade of wheel on a given job.

CUTTING ACTION AND WHEEL-LIFE

The cutting action of the wheel is a very important factor in most roll-grinding shops as stock must be removed and a satisfactory finish must be produced in a minimum of time. Where the time element is not so important, slightly harder and longer lasting wheels can be used to advantage. Generally speaking, the cutting action with respect to rate of stock removal of a vitrified bonded wheel improves as the grit size is changed from fine to coarse and the grade from hard to soft. With resinoid and shellac wheels, however, coarser grit sizes act harder, so it is generally necessary to go softer in grade to obtain the desired results.

In some plants, the number of rolls ground per wheel or wheel-life seems to be regarded as all important, when actually that last 10 or 15 per cent of additional wheel-life demanded can become very expensive, when it is compared to the loss in production and abuse to equipment encountered in using wheels that are too hard and require frequent dressing. Diamond dressing tools cost money, and the time lost in dressing the wheel is another costly item. After all, the operator is not grinding rolls and producing while he is dressing the wheel and cutting it down, and into the sump with the diamond. All things being equal, the wheel should be worn down on the roll and not with the dresser. Whenever wheel-life is looked upon as the most important consideration, somewhat harder wheels must necessarily be used than where grinding time or rate of production is the primary concern. In other words, we cannot expect 100 per cent wheel life and 100 per cent

production at the same time. In this instance, one must arrive at a happy medium and be satisfied with what is conducive to best operations and costs. An effective incentive system makes it all important to use wheels of correct grading.

PROPER WHEEL SELECTION FOR SPECIFIC APPLICATIONS

There is only one way to arrive at the best wheel for a job and that is by trial on the roll and machine in question. In roll-grinding, this is somewhat simplified because the choice is narrowed down in advance to a relatively small list. We have two abrasives, namely, aluminum oxide and silicon carbide, each of which can be furnished in at least thirty-two grain sizes. For roll-grinding each of these can be had in three different bonds—resinoid, shellac, and vitrified. At least a dozen symbols are reserved for structure. Thus one can readily see that these three combinations give a wide range of wheel specifications from which to choose the right wheel for the job. Factors to be considered in selecting the wheel are:

1. Kind of material.
2. The amount of stock to be removed; accuracy and finish required, and rate of production desired.
3. Type and condition of the machine.
4. Size of wheel and arc of contact between the wheel and the roll.
5. Skill of the operator.

Harder grade wheels may be employed to advantage for heavy stock removal on sturdy machines which are equipped with generous size wheel spindle bearings and motors. Small diameter wheels work better on large diameter rolls due to a narrower arc of contact, allowing the abrasive particles on the wheel face to properly penetrate the hard roll surface and readily remove stock.

GRINDING PAPER MILL AND RUBBER COVERED ROLLS

A great variety of rolls may be found in a paper mill; rolls of many sizes and materials are used. They do not require the high finish of aluminum or steel mill rolls, but they are very long and run at high speeds. At one end of the mill, wood pulp flows on to a wire-mesh belt where the fibers flatten out and mat to form the paper and on the other end, finished paper is slit and wound up into large rolls or coils. Between these two points, the web of paper travels hundreds of feet at speeds of 50 to 1500 fpm, conveyed and processed by rolls of various types; among them are chilled iron, rubber, stonite, granite, brass, and copper. Most mills figure that the time lost in numerous wheel changes would more than offset what difficulties attend the grinding of all these materials with a single wheel and a general purpose compromise wheel is chosen. The chilled iron rolls are most numerous, with rubber rolls second, and the other rolls which are comparatively few, can be ground with the wheel that best suits the iron and rubber rolls. Silicon-carbide abrasive is generally favored and the organic bonds dominate the field, with shellac being favored over resinoid. Grain sizes range from 24 to 60 grit. Roll surfaces must be free from chatter marks and feed lines, and the body must be ground to very close limits and with the correct amount of crown. The problem is to select a wheel of such grain size that it will grind the chilled-iron rolls to a satisfactory finish, and yet be coarse enough to grind rubber covered rolls without excessive loading. The wheel must be hard enough to hold its cut and yet be free cutting so as not to cause chatter marks. The majority of roll-grinders used for reconditioning paper mill rolls are of the two wheel type; although in a few instances conventional single wheel roll grinders are being used. The two wheel grinders have two grinding wheels from 14 to 18-in. in diameter, one on each side of the revolving roll, working against each other to prevent deflection of the long slender roll by wheel pressures. Shellac bond wheels are best suited for these machines.

The rubber covered rolls should be ground often for economy. If the application is dry grinding, a 24 grain wheel is best if there is a free choice; and the wheel should be dressed coarse. A jet of air on the arc of contact will help prevent loading. Hard rubber can be ground at fairly high speed, while soft rubber must be ground slowly with lighter cuts. Wheel corners should be chamfered with a diamond dresser to prevent feed lines. If the work is done wet, which is favored by some, the action is somewhat smoother, with clear water as the best coolant. In this instance, as in numerous other grinding operations, conditions vary. The best solution to many grinding problems can be found by contacting an application engineer to work on the spot with the operators and department supervisors.

DISCUSSION

PRESENTED BY

R. J. FINNIE, Superintendent of Rolls, Sharon Steel Co., Sharon, Pa.

WILLIAM POPE, National Grinding Wheel Co., Inc., North Tonawanda, N. Y.

GORDON M. KYLE, Assistant Superintendent Mechanical Department, Inland Steel Co., East Chicago, Ind.

FRED A. HORN, General Superintendent Hot Rolling Mills, Ford Motor Co., Rouge Plant, Dearborn, Mich.

M. D. STONE, Manager, Research and Development, United Engineering and Foundry Co., Pittsburgh, Pa.

R. J. Finnie: I feel that the author has thoroughly covered practically everything in the roll-grinding field. I can honestly say that the shellac bond wheel, with which we grind our hot mill rolls (nickel chill—nickel grain, and alloy steel rolls) gives the best performance. Also the 180 grain shellac wheel used in grinding forged steel rolls in our cold mill has the best record.

I would like to ask if a two-in. wheel would perform better than a three or four-in. wide wheel in polishing, especially where crowned rolls are involved.

William Pope: When using a two-in. width wheel compared to three or four-in. wheels for polishing, the narrow wheel does have some merit, especially on crowned rolls. When using the narrow wheel you do not have the "drag" going over the top of the crown that

you have with the wider wheels. Of course, the length of the roll and height of the crown enters into this picture, and for conventional roll-grinding, a three or four-in. width wheel is satisfactory. However, for precision, ultra finish jobs, I believe that the two-in. width wheel has its advantages when polishing short, high-crowned, super finish, forged hardened steel rolls.

Gordon Kyle: I would like to ask the author his thoughts on the preferable types of finishes for roll necks, especially cold tandem mill and temper mills using oil sleeve bearings. I am referring to the most desirable type of wheel and to finish on the neck expressed in micro-inches if this is practical.

William Pope: In grinding roll necks for oil bearing back-up rolls, in my experience a very high luster finish or a polished neck is not required, in spite of the fact that some of the bearing manufacturers and lubricating engineers recommend a highly polished finish on the roll necks. For instance, on the five-stand tandem cold mill, we found that the straight neck oil-bearing gave better service with roll necks ground with an 80 grain wheel, than they did on necks that were finished with a 320 grain polishing wheel. This 80 grain wheel produced about an eight micro-inch finish, and we concluded that this finish had a tendency to hold a better oil film than the highly polished surface and thus helped to eliminate some of our bearing troubles.

Fred A. Horn: I would like to know a little more about this shellac bond wheel that you speak of. Is it not the conventional type wheel?

William Pope: Yes it is a conventional wheel. Shellac was used as a bond even before resin, especially for cut-off wheels.

Fred A. Horn: This shellac bonded wheel that you spoke of which is used for grinding cold strip mill hardened forged steel rolls was developed by us some years ago, as more or less a freak wheel; is that correct?

William Pope: No, that is not correct. It is not a freak wheel.

Fred A. Horn: Is it used quite extensively?

William Pope: Yes it is used quite extensively, but it is not a freak wheel. Some of our competitors make shellac bonded roll-grinding wheels. On certain applications, you just can not beat a good shellac bond wheel. It has good cutting qualities and produces a good finish with less effort.

Fred A. Horn: In other words, your type shellac wheel is slightly different, to the extent you feel it is a better wheel?

William Pope: Yes, that is correct. It is conceded that we make the best and most uniform shellac-bond roll-grinding wheel on the market.

Fred A. Horn: I know that some of the hot strip mills are now using cast alloy-steel rolls in the first stands of the finishing mills. This necessitates changing the wheel. Have you developed a wheel that can grind either on steel or iron?

William Pope: Not to the best advantage, no. We use aluminum oxide for grinding steel and silicon carbide for iron. We are now doing a little experimenting with a combination wheel. However, where you have a considerable number of alloy-steel work rolls to grind, it is best to use a 36 grain aluminum oxide wheel made for that purpose. In other words, there still is no wheel made that will do a good job on both iron or steel and do it economically.

M. D. Stone: I would like to ask Mr. Pope, or any of the other wheel grinding wheel makers as to what they recommend or use for the different job of grinding what are sometimes called reflective finish cold mill rolls.

As I understand it, the usual roughness of a cold mill roll when they are ground, is ten to fifteen micro inches. There are some applications at times in which they require a finish as fine as one to two micro inches. What type of wheel and what grit are recommended, and what success have you had in this general area of grinding?

William Pope: When you are talking about one or two micro inch finish on cylindrical grinding, it is not easy. Generally a five or six hundred grain polishing wheel is used. With the right application and a good operator, you can get down to about two or three micro inches with this wheel.

For ordinary conventional cylindrical grinding with a six hundred grain polishing wheel, you get around a three micro inch finish. That has been done. After that, you get into buffing, etc., but the 600 grain wheel does a nice job. It is amazing, though, the difference in a lot of cases depends upon the type of roll. You get a much better job on one roll than you can another. I would say about a two micro inch finish is about the best you can do with a 600 grain polishing wheel.

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ASSOCIATION OF IRON AND STEEL ENGINEERS, 1010 EMPIRE BLDG., PITTSBURGH 22, PA.

EXPERIENCES IN PURGING

Inert gases have replaced steam for purging gas systems . . . . procedures are safer, expansions due to steam temperatures are eliminated, and less time is required . . . .

By HUGH E. FERGUSON
Chief Testing Engineer
The Peoples Gas Light and Coke Co.
Chicago, Ill.

▲ PURGING is a term applied to the practice of preventing the formation of flammable mixtures of fuel gas and air in large chambers or mains by interposing an inert or non-combustible gas. For example, if a gas storage holder is to be entered for examination or repair, the live fuel gas content is first replaced by an inert gas, and then the inert gas is cleared out by an air blower. Similarly, when a newly laid main or newly constructed plant is to be put in operation, it is advisable that the original air content be replaced by an inert gas before filling with a combustible gas.

The inert gases most frequently used for purging are:

1. Nitrogen, or carbon dioxide, from pressure cylinders—provided convenience is more important than cost.
2. Mixtures of carbon dioxide and nitrogen generated through controlled combustion of gas, gasoline or oil in especially designed equipment (Figures 1 and 2).
3. Products of combustion from small boilers, furnaces or engines—where the operation of the equipment can be modified to produce a gas containing very little free oxygen or carbon monoxide.

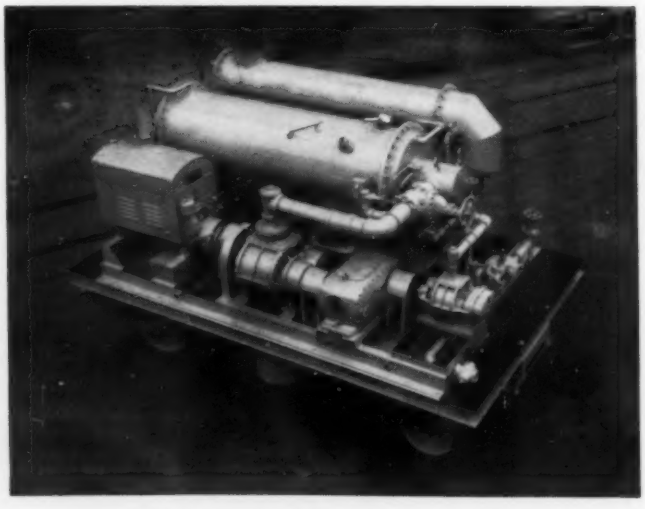
At one time steam was widely used because of its availability in most plants. But experience indicates steam should be used only to assist the inert gas where it is necessary to volatilize liquids or deposits as well as replace gases or vapors.

Replacement of one gas in a chamber by another may take place by one or both of two actions: (a) by displacement with little or no mixing; and (b) by progressive dilution resulting from admixture. Recommended purging practices are directed toward minimizing mixing or dilution—because if the purging is mainly by displacement only one to one-and-a-half volumes of inerts are needed instead of the four volumes required for purging by dilution (Figure 3). To reduce mixing, the heavier inert gas is introduced at the bottom of a chamber, and the lighter fuel gas is displaced upward and vented out at the top. To avoid stirring, the velocity of introduction is kept below 3 fps. Mains under 36 in. in diam may be purged by a "slug" of inert gas about one-fourth of the main length —this "slug" being moved along the main at a moderate speed by introducing the replacement gas (or air) behind it.

Proper isolation of chambers or mains being purged is extremely important—any inleakage of gas during or after the purging can be very dangerous. Most utility

Figure 1 — Equipment has been especially designed to produce mixture of inert gas.

Figure 2 — Inert gas generator equipment is mounted on wheels for mobility.



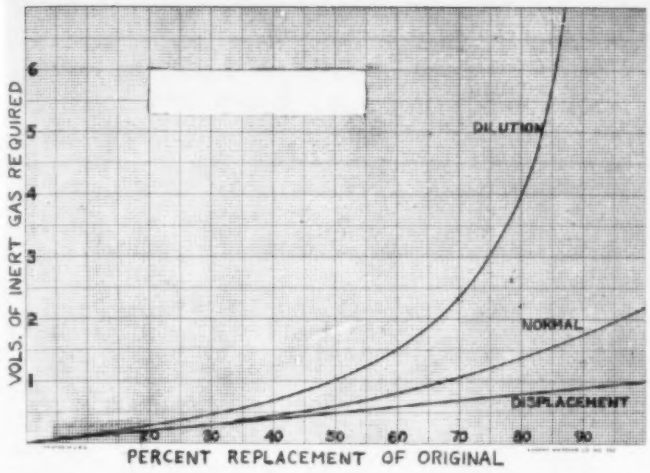


Figure 3 — The volumes of inert gases required for different kinds of purgings are given on the chart. Dilution requires greater volumes.

companies physically disconnect any holders, tanks, towers or other large chambers before purging them. Main sections which can not be disconnected are isolated by inserting metal blanks—or by inserting bags and stoppers downstream from valves which are sealed with liquid after being closed tight.

The theories, general principles and recommended practices of purging are thoroughly explained in a book recently published by the American Gas Association entitled "Purging Principles and Practices." Since the book covers general purging practices in a very capable manner, this discussion consists mainly of the presentation of some short case histories of actual operations, selected in the hope that they will be interesting and informative to engineers in the steel industry. A number of persons in this industry assisted in many of these purging operations, and it is hoped that references to them will be considered as expressions of gratitude for their cooperation.

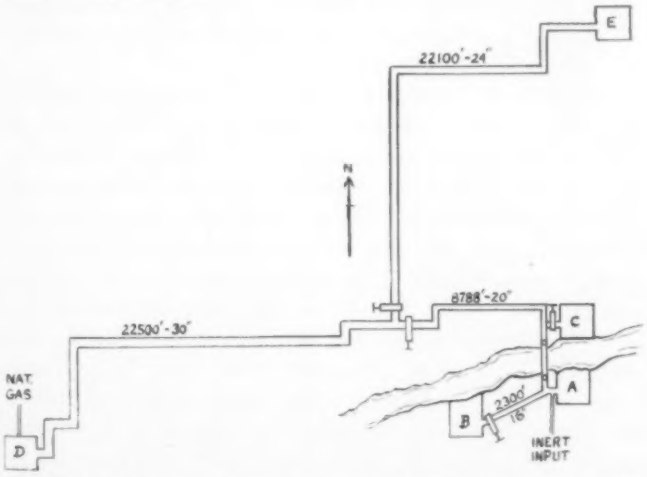


Figure 4 — Layout shows an interplant natural gas main system.

NO. 1 — INTERSTATION GAS SUPPLY MAIN

It is difficult to purge a branched main by use of a quarter-volume slug of inert gas, because it is hard to divide the slug into the proper sizes required by each branch. A good procedure is to fill the trunk or major part of the system with inerts—and to then push the inert gas out through the various branches by introducing the filling gas (or air) at the foot of the trunk.

This system consisted of eleven miles of 30-in. to 16-in. steel main for transferring natural gas at 50 psi across a city from the receival station "D" to four other plants of a public utility (see Figure 4). With surge tanks, station piping and other accessories, the system had a total volume of 210,000 cu ft.

An inert gas generator was set up in Station A and the 8000 cu ft of main volume to and in Station B was first inerted. Then, with the northbound valve at the main junction closed, the main trunk from Station A to Station D was filled with inerts. The valves at the junction were then reversed and natural gas introduced at Station D. The 104,000 cu ft of inerts in the west part of the trunk were thus used to displace the 68,000 cu ft of air in the north branch and Station E. When natural gas reached the junction, the east bound valve was opened and the inerts in the east branch used to purge Station C. The time required, and the volume of inert gas required, were only two-thirds of those necessary for complete filling with inerts.

NO. 2 — STEEL MILL GAS MAIN

This was 4600 ft of 60-in. main with five feet of cover, carrying coke oven gas from a benzol plant to a booster station (see Figure 5). The main volume was about 60,000 cu ft. A 60 x 48-in. L and a valve were to be at-

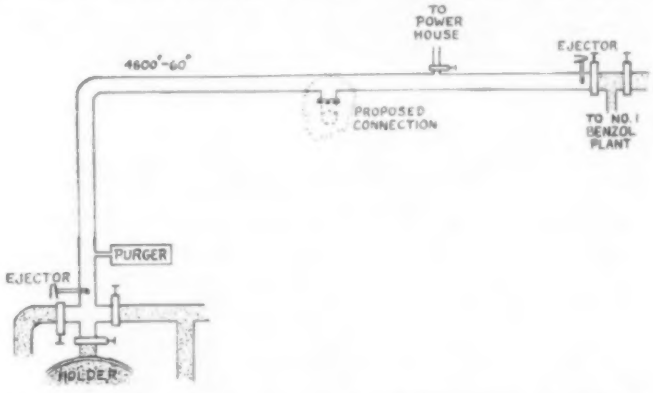


Figure 5 — Layout shows a steel mill oven gas main which had to be purged.

tached to a blanked 60 x 60 x 60-in. T located about 1500 ft from the booster station, for a connection to a new benzol plant.

Preliminary tests indicated that the 48-in. valves at both ends would leak considerable gas during the purging and subsequent working on the underground T. So 4-in. steam ejectors were installed at each end of the main, just inside the end valves. During the purging, these ejectors were operated at low rate so as to maintain 0.5 in. water column backpressure at the inert input point. The original coke oven gas content of the main, any inleaking coke oven gas, and finally the inert gas, were discharged by these ejectors.

The main was so large that almost complete mixing of the inerts and coke oven gas resulted from the inerts flowing along the bottom. When tests indicated the main to be completely inerted, the introduction of inerts was stopped, the removal of the blank from the

T was started, and the ejectors were turned on at maximum capacity to draw the inert gas away from the T and to draw fresh air down into the excavation to protect the workers. This was a fortunate arrangement because there was a delay of 24 hours in making up the connection. But in the interval, the ejectors kept any coke oven gas that leaked through the end valves from reaching the open connection in the 10-ft pit.

After the connection was made, the main was purged back into service in the same manner that it had been purged out—with the ejectors operating at a low rate, but adding enough steam to the mixture of inleaking coke oven gas and displaced air to prevent flammable mixture.

NO. 3 — WATER SEALED HOLDER

The principle that heavier inert gas should be introduced near the bottom of a chamber being purged is illustrated by observations during the purging of a large water-sealed storage holder. When landed, the crown of this holder contained 470,000 cu ft. Inerts were introduced through one invert, and the coke oven gas content vented through a 6-in. opening at the top of the crown. Then air was pumped through the same input invert with the crown valve closed, to displace the inerts downward and out through a second invert.

In spite of 49,000 sq ft of interface through which mixing of the inert and oven gases could occur, samples taken during the purging from the top and bottom of the 16-ft high crown space had decidedly different compositions. See Table I.

TABLE I

Elapsed time	At bottom of crown		At top vent	
	Inerts, per cent	Coke oven gas, per cent	Inerts, per cent	Coke oven gas, per cent
2	65.8	34.2	7.0	93.0
4	68.4	31.6	9.6	90.4
6	70.1	29.9	26.3	73.7
8	75.4	24.6	43.9	56.1
10	84.2	15.8	61.4	38.6
12	87.6	12.4	72.0	28.0
14	93.0	7.0	83.3	16.7
16	94.7	5.3	89.5	10.5

To purge this 470,000 cu ft volume by progressive dilution or admixing would have required 1½ to 2,000 000 cu ft of inerts. But because mixing was kept at a minimum, only 680,000 cu ft, or about 1½ volumes, were actually needed.

NO. 4 — SPHERICAL STORAGE HOLDER

During the severe winters of 1943 and 1944, several large spherical gas storage holders in eastern states failed. In the spring of 1945 an insurance company wished to make a magnaflux examination to detect any cracks or flaws in the shells of four 125,000 cu ft spheres in a coke plant near Buffalo. The operating pressures of these spheres ranged from 5 to 55 psi several times a day.

One of the spheres was disconnected from the plant system—and was purged by introducing inert gas through a 6-in. connection to the bottom manhole, the coke oven gas being discharged through a vent provided by removing the safety-valves at the top. The inert gas was produced in a generator burning kerosene, driven by a 2-cylinder gasoline engine. The purging proceeded in a very satisfactory manner until about the half-way point. Just after the level of the inert gas passed the equator, very severe mixing occurred. This is probably a feature to be reckoned with in purging this type of vessel: when purging back into service, the

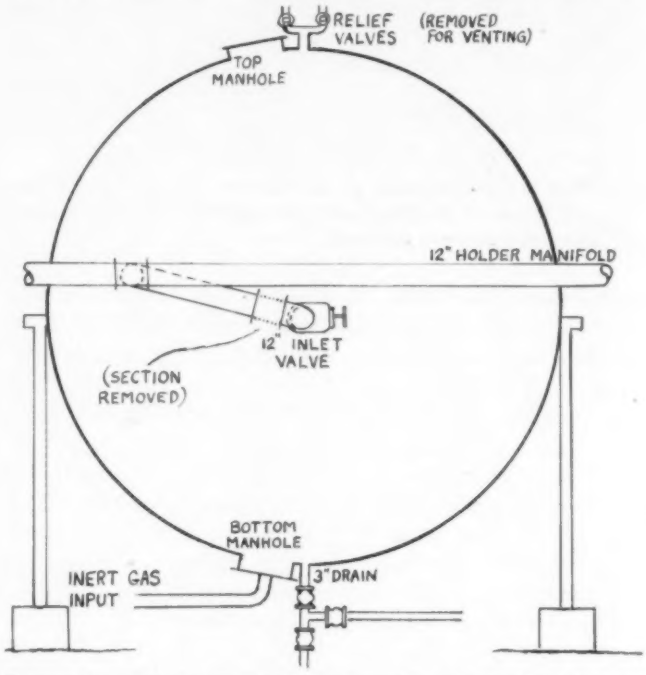


Figure 6 — Proper method for purging a spherical holder is shown.

same complete mixing occurred as the inerts content reached the equator. In returning the holder to service, a two-in. pipe was run to the top of the sphere to admit coke oven gas through the safety-cock connection—displacing the heavier inerts downward and out of the bottom drain connection.

While the insurance company was magnafluxing the first of the four holders, somebody remembered that after investigating the failures of the spherical holders in previous winters, an ASME committee had reported that they were due to stresses in low charpy-impact steel fittings at the bottoms of the spheres—caused by strong upward thrusts of buried main connections resulting from exceptionally severe frost upheavals. All of the holders in this Buffalo plant had side connections, made up in a double swing with Van Stone joints—the only bottom connections being small drain lines. Since the magnaflux inspection of the first holder yielded negative results, the other three were not purged or tested.

NO. 5 — A BANK OF PROPANE TANKS

Even traces of water in systems handling LP gases will cause serious operating difficulties, because solid hydrates will form at valves and control points. Inert gases produced by combustion-type generators may contain 12 to 15 per cent water vapor, and should not be used to purge LP tanks or systems into service. How-

ever purging a bank of such tanks into service by dry nitrogen or carbon dioxide from pressure cylinders can be costly and tedious—particularly since excessive mixing will result from all the connections being located at one end of each tank. As an alternative to inert gas purging, rapid pressuring by natural gas has been used on a number of occasions when putting banks of LPG tanks into service.

A clean 2-in. reinforced high-pressure hose was connected from a natural gas main to the repressuring connection of the first tank—and an electrical bonding connection made from the main to the tank-shell. With all other connections closed, natural gas was admitted to the tank at a rate of about 400 cfm until its pressure reached 21 psi. Then the rate of input was increased to about 1000 cfm until the tank pressure reached 175 or 180 psi. In Table II it will be noted that during pressuring, a flammable mixture of gas and air—(i.e., containing between 4.9 and 15.5 per cent of natural gas)—was present for only about a minute, just after starting the gas input.

TABLE II

Elapsed time, sec	Pressure, psig	Natural gas input, scf	Composition of contents	
			Air, per cent	Gas, per cent
0	0.0	0	100.0	0.0
24	0.7	200	95.3	4.7
90	2.8	750	84.2	15.8
180	5.6	1,500	72.8	27.2
720	22.4	6,000	40.0	60.0
20	74.8	20,000	16.7	83.3
30	112.2	30,000	11.8	88.2
45	149.6	40,000	9.1	91.9
60	179.5	48,000	7.7	92.3

After making a check for leaks, a second high-pressure hose was connected to the vapor release of the tank, and the natural gas was bled off into a large water-sealed holder until the pressure had been reduced to 15 or 20 psi. During this bleeding, the first (input) hose was connected to the second tank and the pressuring of it was started.

In one of our stations, five or six units of a bank of twenty 30,000-gal tanks were thus pressured into service in a day. Each tank had a volume of 4010 cu ft and required about 48,000 cu ft of natural gas to pressure it to 175 psig. In addition to being dry, cheap and relatively fast, this procedure provided conditions for a careful pressure testing of connections, manifolds, etc. But since it is not a true purging procedure, it has not been recommended by the AGA Purging committee.

NO. 6 — PURIFYING BOXES

Purifying boxes (or chambers containing iron oxide for the removal of sulphur compounds from manufactured gas) may present some peculiar purging problems. Serious fires and explosions can occur when such boxes are open to replace the sulphur-saturated "oxide" by new material without first replacing the live gas contents by inert gas. Accumulations of unstable sulphur compounds, cyanides, naphthalene, etc., in such boxes may ignite spontaneously upon contact with air.

In normal operation the raw fuel gas enters at the middle of one side of the box, part passing up through a top layer, and part passing down through a bottom layer, of iron oxide and wood shavings (Figure 7). In purging, the inert gas is introduced at the box *outlet*—with vents open at the top, the bottom, and the normal inlet. This is desirable because the bottom layer of spent oxide is frequently clogged with deposits—so that if the inerts were introduced at the box inlet, little or none would pass through this layer to clean out the bottom. When inert gas is discharged from a vent it is closed: usually the top vent first, then the bottom drain vent. Then the inerts are forced through the oxide beds and out of a vent at the normal gas inlet. This is an exception to the principle that heavier inert gases should be introduced at the bottom of a chamber—but is necessary because very few boxes have large bottom connections.

A direct comparison of the composition of the discharged mixture with that of the original inert gas cannot be used as a measure of progress in purging an oxide box into service, because the raw or new iron oxide will absorb much of the carbon dioxide from the inert gas. As an alternative, the decrease in oxygen content of the escaping mixture, from the normal of 20.9 per cent for air, must be used as a guide.

Messrs. Hagedorn, Chamberlain and Nichols of Interlake Iron Co. were witnesses of a peculiar oxide-box

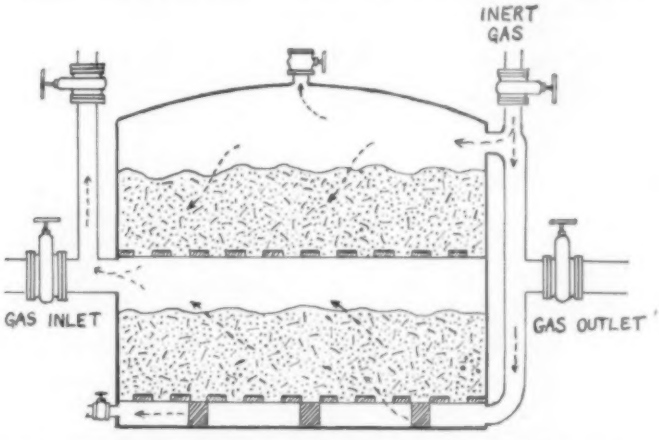


Figure 7 — In purging an oxide box, inert gas is introduced at the outlet.

purging operation in their plant. The inert gas being used contained 9.5 per cent CO_2, 1.3 per cent O_2. But the very first tests of the vented mixture indicated 12.9 per cent CO_2, 0.2 per cent O_2. The box had been filled with oxide and shavings about three weeks previous—during a very rainy spell. For want of a better explanation, it was concluded that fermentation, decay or some reaction between the oxide and wet wood shavings generated enough carbon dioxide to automatically purge the unit. Even though this purging by fermentation has been observed several times, it is considered too uncertain a method to be recommended.

NO. 7 — BLAST GAS UNDERFIRING SYSTEM

To permit replacement of the seal canvas of a million cubic foot waterless holder, the entire system for blast gas underfiring of the coke ovens in a steel mill had

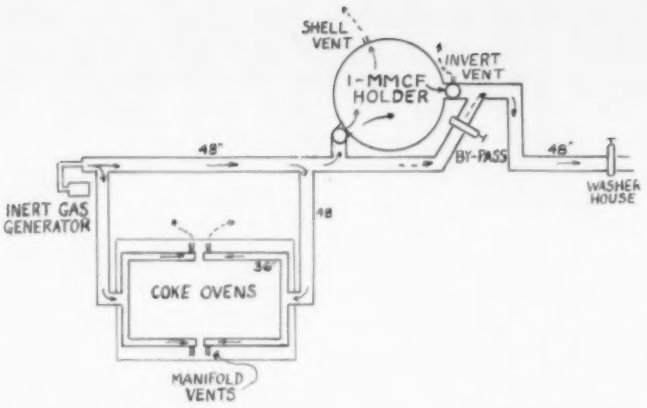


Figure 8 — Method of purging an oven underfiring system is shown by schematic.

to be purged (Figure 8). Included were 4000 ft of 48-in. main, several hundred feet of 36-in. firing mains, and the 50,000 cu ft base space of the holder—a total of about 175,000 cu ft. Isolation was effected by a water-seal in the blast-gas washer house. Since the only valves available were the relief valves at the ends of the firing manifolds, and a holder by-pass, the inert gas was directed into the various parts of the system by regulating the points of escape of the displaced blast gas.

An inert gas generator was connected near the end of the 48-in. holder outlet main. In the first stage of the purging, all the outlets from the system were closed except the relief valves at the ends of the east firing mains. Thus the inert gas being introduced could only travel into, and displace the live blast gas from, the east firing mains. When these mains had been inerted, the relief valves at the ends of the west firing mains were opened—and the east relief valves closed. This permitted the inert gas to travel part way along the 48-in. trunk main to the west manifold, and thence on through the west firing mains, displacing the blast gas ahead of it.

When all of the firing mains had been filled with inert gas, their vents were closed—and a vent in the invert at the far side of the holder was opened. To insure proper displacement of all the blast gas from the space under the landed piston of the holder, a 3-in. opening was made through the holder shell opposite the inlet and outlet inverts. When tests at these holder vents indicated that the space under the holder piston was filled with inerts, the holder by-pass valve was opened and the main from the holder to the washer seal was purged. Then the holder inverts were sealed with water to avoid the possibility of tar vapors seeping out into the mains. After holder repairs had been completed, purging back into service was performed in the same manner.

The underfiring systems of coke ovens in a number of steel mills in Chicago have been purged in the fore-going manner—the average time required being about four hours.

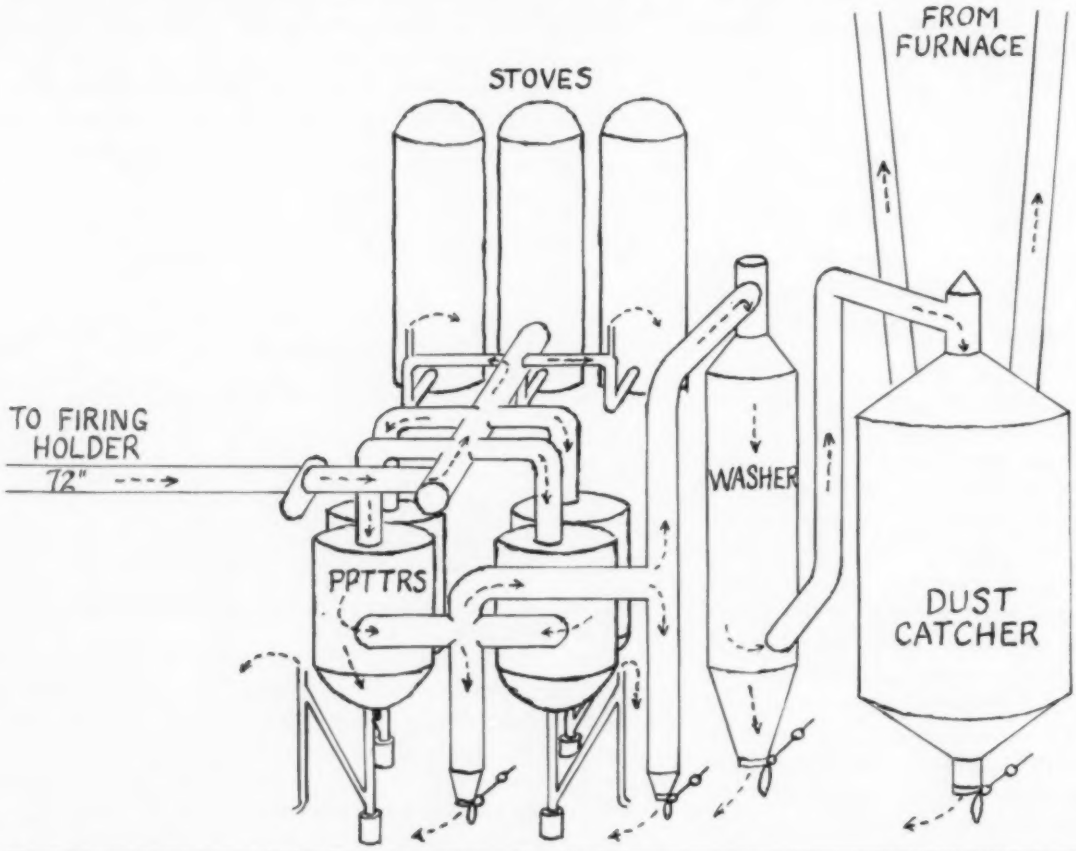


Figure 9 — In purging blast gas equipment, method of introduction is more flexible since density of blast furnace gas is similar to that of inert gas.

NO. 8 — BLAST FURNACE GAS CONDITIONING EQUIPMENT

The density of combustion products used as an inert gas in purging operations is very nearly the same as the density of blast-furnace gas. So that in purging blast-furnace equipment, it is not important that the inert gas be introduced at the bottom of a chamber in order

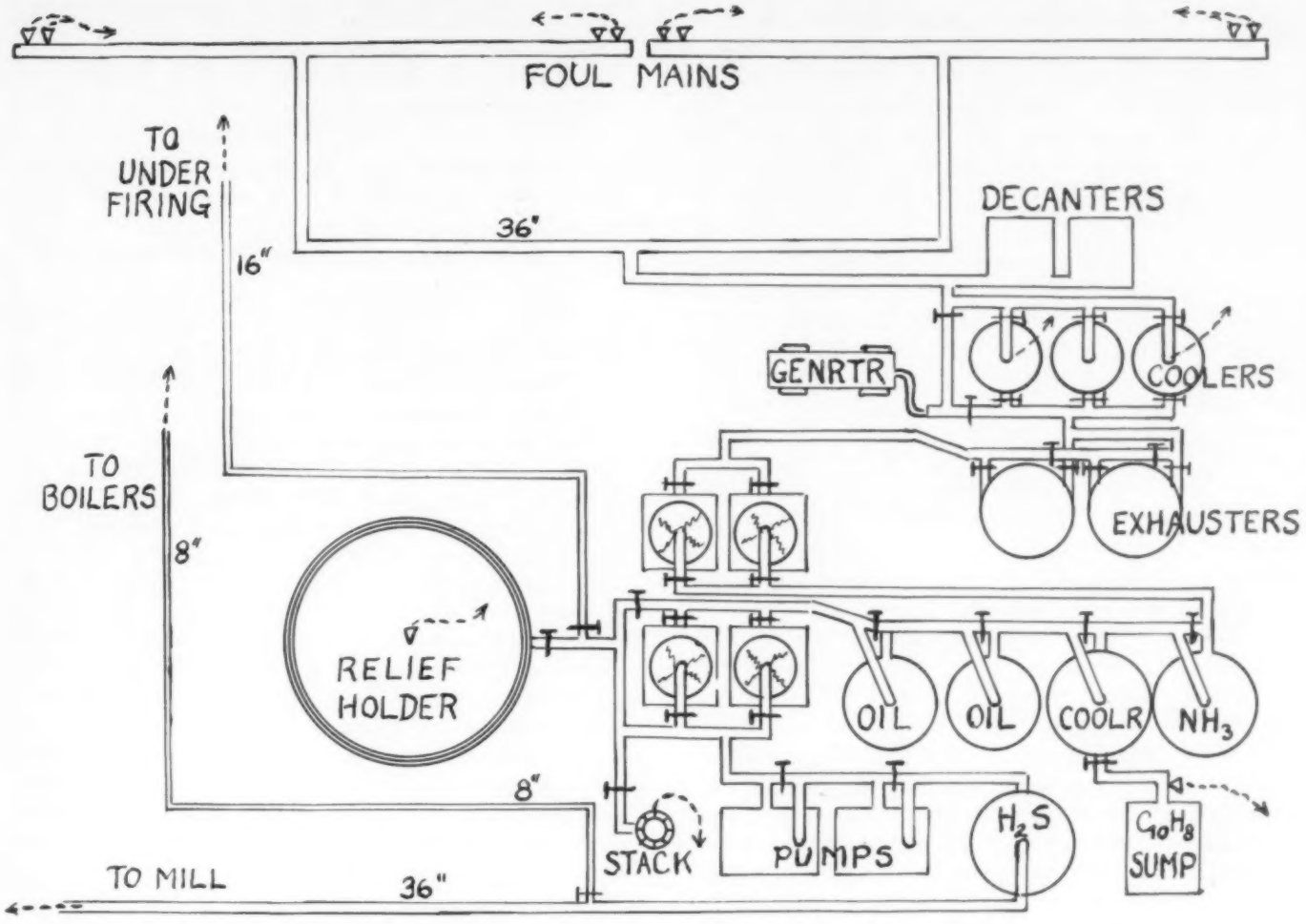


Figure 10 — Purging of oven gas equipment must be done systematically.

to minimize mixing. In several purgings of equipment for cleaning blast-furnace gas, satisfactory results were obtained by introducing the inerts at the downstream end of the system and displacing the blast-furnace gas counter to its normal direction of flow (Figure 9). This resulted in the inert gas entering at the top and exiting near the bottom of each of the various chambers. It permitted discharging the bulk of the blast-furnace gas contents of the system high in the air near the furnace top—and also made it possible to use the bottom clean-outs and drains of the various chambers as secondary vents and test points.

In one specific operation, the inert gas generator was connected to the blast-furnace gas system at a point between the underfiring holder and the coke ovens (as described in the preceding example.) After the oven-firing manifolds and the holder base had been purged, the inert gas was directed into the precipitator outlet manifold by disconnecting the burners of the preheating stoves. When tests at these burner vents indicated 75 per cent inert gas, they were closed off and a 10-in. valve at the base of the dust-leg in the precipitator inlet manifold was opened. The precipitators were then unsealed and their bottoms purged through the drain valves.

When tests at the precipitator drains and the dust-leg were satisfactory, they were closed and the clean-outs at the bottom of the washer and the dust catcher were partly opened to permit inerts to travel into them and thence out through the downcomers from the furnace top.

Purging of the underfiring holder and oven mains took from 11:30 am to 2:30 pm; at 3:40 pm the system was inert as far as the preheater burners. At 7:30 pm all four precipitators had been inerted—and at 11:00 pm the content of inert gas in the dust catcher was such as to permit stopping the inerts input.

NO. 9 — COKE-OVEN BY-PRODUCT PLANT

This case is the starting-up of a new by-product coke-oven plant with a complete purging from foul mains to underfiring mains. The ovens had been fired to operating heat by natural gas for some time, awaiting delivery of coal.

The inert gas generator was connected into the by-products system just ahead of the works exhausters (Figure 10). In the first stage of the operation, the foul mains and the mains to the by-product plant were purged. The inlets and by-passes of the exhausters were closed, and displaced air was vented through valves in the top passes of the condensers (or primary coolers) and through two 2-in. spoon-holes at each end of the two foul mains. No attempt was made to purge the decanters which were filled with steam.

In the second stage, the bulk of the gas-conditioning equipment was purged along the normal path of travel —from the 12-in. by-passes around the exhausters,

through the precipitators in parallel and each scrubber in series, to the plant bleed-stack. In each piece of equipment, the inert gas entered at the bottom and exited at the top, minimizing mixing of the inerts with the original air contents. The displaced air was vented at the naphthalene sump of the secondary cooler, at the outlets of the secondary Cottrell precipitators, and at the plant bleed-stack.

In the third stage, the relief holder and the compressors and mains for transferring gas to other parts of the mill were purged. The air displaced from the holder was vented through a 4-in. valve in its crown. When the holder crown had been inerted, this top vent was closed and an attempt was made to lift and partially fill the holder with inert gas—the intent being to subsequently use this stored inert gas for purging the mill transfer mains. The inert gas generator could produce only 10 in. water column of the 15 in. water column required to raise the holder lift, and even at its lowest operating rate, a works exhauster caused a vacuum at the outlet of the inert gas generator. Therefore the holder was left in a landed position. To permit the mains for transferring coke-oven gas to the oven-firing control room, to the boiler room, and to the steel mill proper to be purged by inert gas travelling through the by-products plant, all the scrubber by-pass valves were opened.

These first three stages of the operation required about nine hours—from 1:00 pm. to 10:00 pm. Then the mains and equipment which had been inerted were pressured to about 5 in. water column with inert gas and bottled-up by closing the primary cooler outlet valves, the exhauster inlet and by-pass valves, and the vents and valves at the ends of the out-going gas transfer mains. Valves within the by-product plant and at the relief holder were left open.

The initial oven charging was scheduled for 8:00 am the next morning. At 7:00 am tests at the spoon-holes indicated some air inleakage had occurred at those points overnight—either because of the constant circulation of hot water through the foul mains, or because the clean-out plates of the riser pipes of the ovens had been left ajar. Tests at the ends of the other mains and at several points in the plant failed to disclose any other inleakages. The dioxide content of the inert gas in the vicinity of the sulphide scrubber had been lowered from 9 to 3 per cent by the alkaline solution being slowly circulated.

The fourth stage of the operation consisted of first clearing out the foul main air inleakage, and then holding the gas-gathering system in an inerted condition until gas production was established. When the inert gas generator was started up the second morning, the outlet valves of the primary coolers were opened halfway to permit some of the inert gas to travel toward the ovens to clear out the air inleakage, and the rest to repack the by-product plant equipment. A steady stream of inert gas was kept flowing into the foul mains until the fifth or sixth oven was being charged—by which time the evolution of gas in the first oven was evident at the spoon-hole vents. Then the inert gas generator was shut down and disconnected.

Replacement of the inert gas by coke-oven gas followed the same pattern as the replacement of the original air content. The inert gas from the foul and gathering mains, and the by-product plant equipment was discharged through the plant-bleed stack; the relief holder was emptied through the crown valve, and the mill mains were cleared through the same vents used during the inert gas filling.

NO. 10 — UTILITY COMPANY EXPERIENCE

The last case-history being offered is not a specific purging operation. It is an outline of the general experience of the local gas utility company with inert gas purging.

The first purging of any gas storage holder into service by inert gas was performed by The Peoples Gas Light and Coke Co. in 1928—using combustion-produced inerts from a home-made generator having a capacity of about 20,000 cfhr. A few years later, our inert gas pumping activities had been expanded to include all scrubbing towers, purifying boxes, and similar major units of plant equipment—for which a mobile generator having a capacity of 35,000 cfhr at 6 to 7 in. water column was designed and constructed (Figure 1). Since 1938 we have purged two or three holders and ten or twelve purifying boxes out of and back into service each year—in addition to a large number of purgings of parts of plants to permit installations of gas reforming and mixing equipment, new compressors, new holders, oil-gas production facilities, etc.

Development of the use of generated inert gas for purging of major equipment has been paralleled by the development of the use of the exhaust gases of truck engines, mobile welding units and street compressors for the purging of mains and small plant equipment. When a second mobile generator having a capacity of 50,000 cfhr at 1 psi was acquired in 1947 (Figure 2), small-volume purging activity was also expanded by adopting the use of pressure-cylinder nitrogen for purgings in plants of some large industrial customers. The present company routines provide for inert gas purging of any fuel gas mains 4 in. or larger in diam, and of any equipment containing more than 100 cu ft of fuel gas.

Our experience with inert gas purging has been such as to convince us that all industries handling large quantities of fuel gases or flammable liquids should have equipment and personnel available for such operations—and should adopt an extensive purging policy as a part of their construction or maintenance activities. In nearly 30 years, we have not had a fire, explosion, or lost-time injury attributable to air-gas or air-vapor mixtures during construction, installation, repair, or removal of plant equipment or mains.

SUMMARY

Several unusual purging operations have been described—in the hope that their recounting will be of use in solving peculiar problems that may be encountered, and in increasing an appreciation of the practical value and utility of inert gas purging.

DISCUSSION

PRESENTED BY

F. R. PULLEN, Fuel Engineer, Bethlehem Steel Co., Johnstown, Pa.

H. I. RIEGEL, Superintendent Utilities, Kaiser Steel Corp., Fontana, Calif.

W. M. DOUGLAS, Combustion Department, Inland Steel Co., East Chicago, Ind.

H. L. HALSTEAD, Assistant Fuel Engineer, Bethlehem Steel Co., Sparrows Point, Md.

W. H. COLLISON, Plant Superintendent, Blast Furnaces and Coke Works, Great Lakes Steel Corp., Ecorse, Mich.

FRANK S. SWANEY, JR., Combustion Engineer, Jones & Laughlin Steel Corp., Pittsburgh, Pa.

HUGH E. FERGUSON, Chief Testing Engineer, The Peoples Gas Light and Coke Co., Chicago, Ill.

F. R. Pullen: I certainly hope that your excellent record goes on for many more years. Thirty years of purging with inert gas without incidents that are accidental in nature is a wonderful record. Those of us that may still be using steam or other purging mediums certainly should give serious consideration to the use of inert gas for purging purposes.

I think this is a good point. On all jobs where it is necessary to have men go inside tanks, vessels or pipes, we certainly must provide forced ventilation. In some cases, an actual self-contained supply of oxygen for the man may even be necessary.

Harry I. Riegel: The paper presented has been very interesting, in that it covers a field which is rarely discussed in meetings of this type. It could be that the fuel engineers consider this type of operations routine, or could it be that they do not wish to bring back memories of just what could have happened had a slip been made, resulting in explosion which damaged equipment and hurt personnel. The experiences related are varied and cover most conditions which one would normally encounter except possibly the purging of oxygen lines. We use bottled nitrogen for purging oxygen lines whenever any cutting or welding must be done. For purging gas lines we have a 15,000 cfhr inert gas machine burning kerosene. This machine is located at a central point and piped to a number of critical gas lines. All of the purging lines are blanked at the gas lines except one. By so doing, we are prepared for any eventuality on short notice.

The planning of a purging job is probably more important than doing the job itself. We find that proper scheduling of each operation, the assignment of personnel based on the requirements of the schedule with proper instruction as to their part in the program and finally, the assignment of one person in charge of the job with all men reporting as to the progress of the operation to that man are essential steps in a purging operation. The man in charge must know the system thoroughly, know the limits of equipment at his disposal, and be authorized to change the schedule as found necessary. Our experience has indicated that proper and realistic planning will permit a job involving purging to be done faster, with less manpower, safer, and on time.

W. M. Douglas: Prior to 1948, steam was used almost exclusively as a purging medium at Inland's Harbor Works. During 1948 a combined blast furnace gas and coke oven gas system was purged with carbon dioxide to prepare the system for major alterations involving burning and welding procedures. The results of the carbon dioxide purge proved to everyone connected with this job that carbon dioxide or nitrogen were far superior to steam as a purging medium.

Two main objections to the use of steam as a purging medium exist. First, steam will raise the temperature of a line, causing the line to expand to an extent that difficulties are encountered when blanks are placed in flanges, when spools are removed, and during other pipe fitting procedures. Secondly, an interruption of steam introduction into a line under purge, may allow the line to become negative in pressure, thereby causing air to be drawn into the line. A gas line under negative pressure prior to complete purging, immediately becomes dangerous.

Since 1949, carbon dioxide, nitrogen and cooled exhaust gases from a gasoline engine driving an air compressor, have been used as inert gases for purging purposes. Systems purged include blast furnace gas lines, surplus coke oven gas distribution lines, and acetylene mains and lines. Both nitrogen and carbon dioxide are obtained via truck in liquid form. The liquid is vaporized by a steam heated or gas fired heat exchanger to supply the purging gas. Rates of purge are adjusted by controlling the flow of liquid to the heat exchanger. Small lines are purged with bottled nitrogen.

The steel mills have found that much less time is required to purge a gas system with carbon dioxide or nitrogen than is required when purging is done with steam.

H. L. Halstead: Our experiences in purging plants and mains have been similar to the ones described in Mr. Ferguson's paper but confined entirely to steel plant operations. Worth mentioning I believe is our extensive use of carbon dioxide as a purging medium. At our plant approximately 10 tons of liquid carbon dioxide is maintained in mobile storage. This together with self contained and portable evaporators makes approximately 160,000 cu ft of inert purge gas always available. Its use we believe is more than convenient. Simplicity of the unit and freedom from any outside source of service—such as fuel, water, electric power—make for superior reliability as a source of inert gas. Such reliability is important from a safety standpoint and also from the standpoint of jobs in which downtime of important production equipment places a premium on timely job execution.

In addition, as a part of our blast furnace gas system, we have a so called "purge" fan permanently connected to our furnace gas mains. When necessary, this fan can pump the combustion products from one of our boilers into the furnace gas mains.

W. H. Collison: In opening this discussion, I wish to quote in part from Mr. Ferguson's next to last para-

graph: "Our experience with inert gas purging has been such as to convince us that all industries handling large quantities of fuel gases or flammable liquids should have equipment and personnel available for such operations—and should adopt an extensive purging policy as part of their construction or maintenance activities."

Great Lakes Steel blast furnace division to a considerable extent meets all the conditions of this sentence.

The plant has a fuel oil fired portable inert gas generator used on occasion for purging pieces of equipment or isolated or short sections of mains. The chief purging operation to be described, however, is that of purging most of the blast furnace gas equipment and mains because of work stoppages, and is accomplished mostly by means of inert flue gas pumped back from a nearby central power station through the main which ordinarily supplies that station with blast furnace gas.

The main is 42 in. diam, 3500 ft long, and carries normally 50,000 cfm blast furnace gas at 55 in. water column. For purging back, 3000 cfm flue gas at 12 in. water column, cooled in a gas washer and driven by a suitable fan is used. The gas will average about 13.5 per cent carbon dioxide, 4.5 per cent oxygen, with carbon monoxide and hydrogen practically nil.

This plant was installed years ago when there were only two small furnaces and interruptions of gas supply were more frequent. Now there are four large furnaces, and a new booster station, mains and purging systems are under construction to a second power plant, likewise under construction. The main to this plant is 4100 ft long, 54 in. diam and is expected to carry 83,000 cfm gas at 80 in. water column. The purging system will have a capacity of 5700 cfm at 12 in. water column.

In the case of shutdown of all four furnaces, usually one at a time, gas to the power plant will be cut off and that main will be purged back. Normally dust catchers, gas washers and precipitators will be steam purged, each having been isolated, at each furnace as it is shutdown. As soon as the last furnace has been shutdown, purge gas will be started backward through the booster station into the clean gas main. The problem is then one of purging a system of many branches or laterals, all of which must be purged, including connections to boiler burners, stove burners, down legs, etc. This is done by opening vent valves suitably placed, or drain valves as the case may be, always so that there is positive pressure and definite flow, starting at the booster station and progressing to the point farthest from the booster station. Blast furnace gas holder and mains to coke ovens are ordinarily isolated, under gas pressure, goggle valves being used. While an Orsat apparatus is used regularly to check combustion and completeness of purging with the inert gas generator, in the main case described, odor of gas and appearance are the only checks used. The purge gas, because of a certain amount of fume and moisture, has a characteristic appearance and odor. Despite the doubt there may be in some minds, this procedure when carried out by men of judgment and experience such as the blast furnace and coke plant superintendents, is safe. The many points to be checked in the limited time, with the regular Orsat operators on the wrong side of the picket line, leave little alternative to this method.

This is an overnight job. Strangely enough, it is usually performed at night.

This is a purging equipment installation not often considered or applied which may have application in some steel plants.

Frank S. Swaney, Jr.: Mr. Ferguson is to be commended for an interesting paper on a subject which, judging from his experience, he is most familiar. With the ever increasing pressure on safety, his presentation should give us all a handy reference in planning our own plant purging operations.

In this connection Mr. Ferguson's recommendation that all lines larger than 4 in. and all gas volumes in excess of 100 cu ft be purged may well serve as a guide in determining what should and what should not be purged.

We would like to have Mr. Ferguson comment on the following questions:

1. What instruments or analyzing equipment have you found useful in your purging operations?
2. What are your thoughts on the relative cost of a mobile gas generator vs cylinder gas?
3. If only cylinder gas is available, is there any advantage one over the other between N_2 and CO_2?

Hugh E. Ferguson: The following is offered in reply to questions by Mr. F. S. Swaney of Jones and Laughlin Steel Corp. In our opinion on the most useful instruments in a purging operation are the following:

1. At the inert gas input location, an Orsat burette to determine the composition of the inert gas being used, a thermometer to insure proper cooling of generated gases, and a water manometer to assist in maintaining an even input and insuring a positive though slight pressure in the equipment being purged. During complicated plant purgings we use a 0 to 20. in. water column pressure recorder at the inert gas generator, which permits the operator to follow the various valve changes.

2. At midway vent points when purging out of service, a sampling bag equipped with a burner to test flammability of escaping mixtures (and also water manometers to insure positive pressure). When purging into service, a small portable oxygen indicator to determine concentrations of residual air in the escaping mixtures.

3. At the end vents, an Orsat burette to determine the composition of the gas being vented, and the sample bag with burner for a check of non-flammability—with water manometers for pressure insurance.

I would rather not let the feature of relative cost play too important a part in deciding between a mobile gas generator and cylinder gases for purging. The usual cylinder will deliver 220 cu ft of inert gas—and where a number of small purgings are anticipated, it is quicker and easier to connect up a couple of cylinders (if the exhaust gases from a gasoline engine are not available). But for purging more than a few thousand cu ft of space, the mobile generator is faster and surer.

As between carbon dioxide and nitrogen, the former has an advantage in that the purging can be followed and controlled through the easy determination of the dioxide in the exiting purge gases. But the rates of discharge of dioxide from cylinders must be kept rather low to avoid freezing—so we prefer and use nitrogen when the circumstances indicate cylinder gas to be desirable.

Figure 1 — View of United States Steel's new Research Center in Monroeville, Pa., shows the Edgar C. Bain Laboratory for Fundamental Research on the left and the three buildings of the Applied Research Laboratory on the right.

U. S. Steel Opens New Research Center

▲ THE United States Steel Corp., formally opened its new Research Center at Monroeville, Pa., on May 7, 1956.

Consisting of the Edgar C. Bain Laboratory for Fundamental Research and the Applied Research Laboratory, the research center marks an important step in United States Steel's continuing program of improving steelmaking methods and developing new steels and new uses for steels to meet the ever-changing needs of customers.

It is said to be the largest and most modern laboratory ever built by the steel industry.

In four modern buildings, hundreds of skilled technicians work on projects in connection with raw materials processing; refractory and mineral technology; sheet, bar, plate and forged products; chemical metallurgy; physics and analytical chemistry; electrochemical engineering; and other related studies.

The laboratory for fundamental research is named after Dr. Edgar C. Bain, vice president-Research and Technology of United States Steel.

Figure 2 — Pilot electrolytic tinning lines such as this one were used to develop the electrolytic tinning lines now in operation at U. S. Steel's mills. This pilot line is currently being used to develop new and improved techniques and treatments.

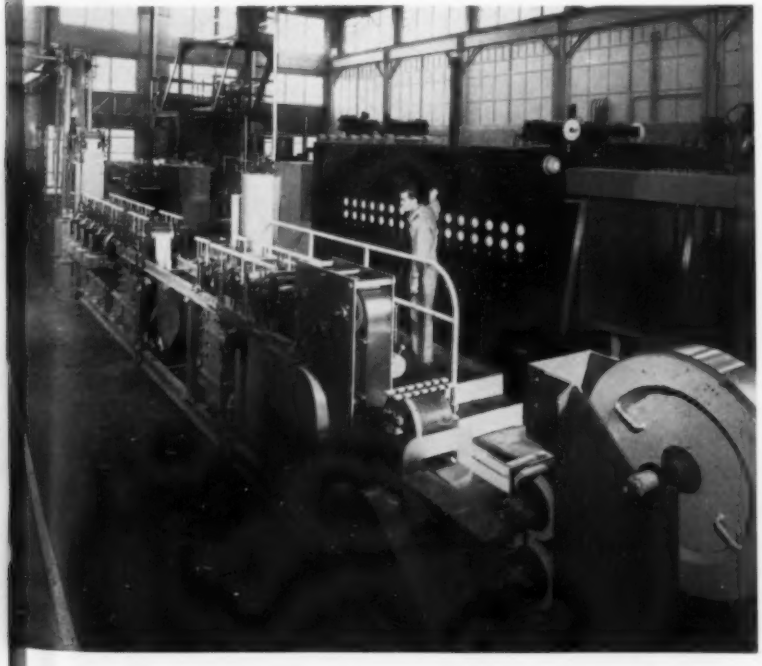


Figure 3 — Over 300 lb of coke is pushed from one of four experimental coke ovens. In the coal evaluation area, different types and various combinations of coking coals are tested in the ovens to determine the most satisfactory blends.

Pictorial Review . . .

1956 AISE SPRING CONFERENCE

LORD BALTIMORE HOTEL, BALTIMORE, MD.

APRIL 30, MAY 1, 2

Members of the Board of Directors and the AISE staff are pictured at the dinner (1) preceding the three-day Spring Conference, which drew a total of 991 registrants, some of whom are shown in (2).

Authors and chairmen who participated in the various technical sessions got together at breakfast to work out last-minute details. Rolling mill session (3) included: H. I. Smith, Jones & Laughlin Steel Corp.; J. C. Seibert, Bethlehem Steel Co.; and H. H. Campbell, Phoenix Manufacturing Co.; (seated), and C. S. Lambert, Youngstown Sheet & Tube Co.; and R. P. Schuler, Inland Steel Co. (standing). In (4) are members of the electrical session: (seated) C. Allan Schurr, Electric Controller & Manufacturing Co.; A. W. Schlechte, Granite City Steel Co.; R. T. Winterringer, Republic Steel Corp.; and J. E. Peebles, General Electric Co.; and, (standing), E. H. Browning, and L. F. Stringer, Westinghouse Electric Corp.; and D. C. McCrady, Steel Co. of Canada, Ltd. The second rolling mill session (5) included: A. M. Cameron, Atlas Steels, Ltd.; Harry S. Beers, Wickwire Spencer Steel Div., The Colorado Fuel and Iron Corp.; W. E. Dittrich, Inland Steel Co.; and J. N. Imel, Jones & Laughlin Steel Corp. Pictured in (6) are members of the mechanical session: H. R. Knust, Bethlehem Steel Co.; and C. W. Bruce, Republic Steel Corp.; (seated), and L. M. De Marco, Stupakoff Div., Carborundum Co.; E. C. Denne, Jr., SKF Industries, Inc.; I. D. Pottorf and R. H. Davis, U. S. Steel Corp. (standing). Participants in the third rolling mill session (7) were: J. H. Taylor, United Engineering and Foundry Co.; C. E. Peterson, Mackintosh-Hemphill Division, E. W. Bliss Co.; F. C. Kredel, Republic Steel Corp.; and R. C. Schaefer, Wheeling Steel Corp.; (seated), Wayne Belden, Ajax Flexible Coupling Co., is standing. Combustion session (8) members were: W. J. Scharfenaker, Steel Division, Ford Motor Co.; J. E. Hovis, Gas Machinery Co.; F. Bruce Bevelheimer, Steel Division, Ford Motor Co.; G. H. Krapf, U. S. Steel Corp., and J. M. Hess, Bethlehem Steel Co.

Again this year the meeting featured an off-the-record rolling mill panel discussion (9). Among those participating were: Dr. Charles Peck, Carnegie Institute of Technology; Don Horsman, Continental Steel Corp.; Louis Moses, Bethlehem Steel Co.; Dr. F. H. Allison, Jr., Blaw-Knox Co.; R. C. Schaefer, Wheeling Steel Corp.; and Howard S. Orr, U. S. Steel Corp.

Typical meeting room scene is shown in (10).

A. F. Beighley and Harry Angel of Bethlehem Steel Co. (11) chat with Wade Hoffman, Jones & Laughlin Steel Corp. Relaxing between sessions (12) are: M. P. Orr, Mackintosh-Hemphill Div., E. W. Bliss Co.; H. E. Muller, Inland Steel Co.; Sheridan Smith, Steel Co. of Canada, Ltd.; and Frank Zipf, Bethlehem Steel Co.; M. L. Weikert, Bethlehem Steel Co. and Harry Evans, Steel Co. of Canada, Ltd.

Shown at the reception (13) preceding the banquet Tuesday evening are: A. J. Berdis, superintendent, Fairless Works, U. S. Steel Corp.; V. J. Pazetti, superintendent, Bethlehem Plant, Bethlehem Steel Co.; and Leonard Larson, chief engineer, Republic Steel Corp. Also at the reception (14) were: S. J. Cort, vice president, Bethlehem Steel Co., who was guest speaker at the banquet, and W. H. Collison plant superintendent, Blast Furnace and Coke Works, Great Lakes Steel Corp., and AISE President.

A total of 607 registrants attended the banquet (15) while 459 made the inspection trip to Bethlehem's Sparrows Point plant. Two of the 10 buses are shown in (16).

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PROGRESS IN PRODUCTION

By STEWART J. CORT
Vice President
Bethlehem Steel Co.,
Bethlehem, Pa.

. . . from a talk given at the informal stag dinner of the 1956 AISE Spring Conference, Baltimore, Md., May 1, 1956 . . . .

▲ SEVEN years ago I had the opportunity of meeting with the AISE and discussing some of our common problems and prospects. At that time I took as the theme for my remarks the inscription on a photograph of Mr. E. G. Grace, chairman of Bethlehem Steel, which hangs in my office. It reads: "Always more production." My paper on May 2, 1949, dealt with the topics of how we could get more production, the obstacles that stood in the way, and what possibilities were being realized.

Today the theme of more production is just as pertinent as it was then. Accordingly, you might be interested in a brief review of what has been accomplished since I last spoke to this group. What problems have been solved or are on the way to solution? What new problems have arisen?

As I pointed out previously, the Association of Iron and Steel Engineers is closer to the grass roots of production than any other engineering group associated with the industry. You men are well aware that production is not something that you get by just speeding up equipment because someone says that a ten per cent addition to output is needed. It is a highly complex process dependent on many factors. Accordingly, I might as well begin at the beginning, with the raw materials situation.

When I last spoke to you, I made the observation that if someone could wave a magic wand and suddenly add 10,000,000 more tons of furnace capacity there would not be the raw material to support it. That was true as of then. But since 1949, not 10 but more than 30,000,000 tons of additional ingot capacity have been added and somehow we are getting the ore to support this growth. New foreign ore sources have been opened up, notably in Latin America and Labrador, and very important progress has been made in the beneficiation of low-grade domestic ores. Today, in spite of the high costs involved in bringing foreign ores to American furnaces, and in beneficiating domestic ores, we must take a rather more optimistic view of the iron ore picture than was possible back in 1949. Very real progress has been made on this front.

Seven years ago, I pointed out that with respect to coal supply much of the good high volatile coal in the country had been or was being exhausted very rapidly. Increased mechanization of the mines, made necessary by the high cost of mine labor, made for dirtier coal and forced on us the new cost burden of coal-washing equipment in the mines. That situation is, of course, still with us and will continue to be. But with washing, we have been able to maintain a fair degree of uniformity as regards ash and sulphur content. We can tell pretty well what we are getting and cut our cloth accordingly.

With respect to scrap, I was able to paint a fairly optimistic picture when I last spoke to this group. Battlefield scrap was beginning to come back to the United States from Europe and the Orient. Obsolete ships and other equipment were becoming available for scrap and we had learned some useful and permanent lessons in the economic handling of scrap, such as better sorting, recovery of alloys, better bundling, and the recovery of scrap from slag banks and plant refuse.

However, I did point out that with any addition to our steel producing capacity, the metallics would have to come from iron ore rather than from scrap because by better metallurgical processes, we have increased ingot yields and thus cut down on the amount of home scrap available. Also, better quality steel extends the life of products made of steel which means the cycle is longer before the steel comes back to the plants as scrap.

If that was the case back in 1949, consider how much greater our dependence on ore for metallics is now than it was then. I had not anticipated in my previous paper the effect on the situation of what has become a worldwide drive to increase steelmaking capacity. This mighty surge in expansion is taking place in 30 different countries. Within four years, the world's capacity to produce steel will be increased by an estimated 87,000,000 tons or about 29 per cent above the present potential, which is estimated to be about 297,000,000 net tons a year.

There are a number of reasons behind this development, which has been called a second industrial revolution. There is the desire to satisfy the demand of expanding populations for more consumer goods made of steel—automobiles, refrigerators, small appliances and other household items. There is also the effort to provide more and better homes, new schools and highways, new and more efficient factories, increased productivity, higher standards of living, more self-sufficiency and materials for defense.

In some cases, nations seek their own steel industry or the enlargement of existing facilities to reduce the drain on their foreign exchange. Nationalistic pride is

another motivating factor. Whatever the reason or reasons, however, you have only to look at the latest quotation on the scrap market to see what the effect of the world-wide movement is on our own situation. And I should suspect that this situation will be with us for a long time to come. Underdeveloped countries do not generate their own scrap as does an advanced industrial civilization such as ours. So we export scrap at the rate of around 4,500,000 gross tons annually and pay the highest prices in history for what we buy at home. I will leave it to others to appraise the wisdom of this process.

On balance, I should say that the steel industry stands in a better position with respect to raw materials today than when this group last met in Baltimore. Rich new foreign iron ore sources have been opened up, the technology of beneficiating low-grade ores has advanced from the pilot plant to the production stage and the coal mining industry is in a far healthier condition than it was a few years ago. These developments have been attended by higher costs, but some of those costs are being recovered through the economies effected by putting better raw materials into the furnaces.

However, the soaring cost of building new integrated capacity puts a higher and higher premium on getting more and more production out of existing facilities. In this connection, we are continuing to follow techniques I mentioned in 1949, while experimenting with new methods.

We are still increasing the production of pig iron by enlarging our existing blast furnaces and by the use of carbon bricks in place of refractory bricks in the hearths with the resulting gain of from 15 to 21 in. in the hearth dimension. Better preparation of raw materials going into the furnaces continues to be an important factor in the increase of furnace production and the decrease of coke ratio. This is being accomplished by improvement in quality of coke through coal washing and blending and the construction of additional by-product ovens, by the screening and sizing of ores, sintering of fines, and better preparation and sizing of limestone. Where inadequate blowing capacity was a factor, new blowing equipment has been added.

The output of our open hearths in a great many of the older plants has been increased materially by enlarging the size of present hearths, the use of larger ladles, the addition of heavier ladle cranes to handle the larger heats, new charging and stocking facilities, more efficient checker capacity and automatic combustion control.

The industry is continuing to accumulate experience in the use of oxygen to improve combustion in open hearths. Time has been gained by the introduction of oxygen in the bath to eliminate carbon in low carbon heats—anywhere from 30 minutes to an hour. Research on this subject is continuing.

As I mentioned to you in 1949, whatever the results may prove to be from these oxygen experiments, and experiments along other lines as well, the effort is worth making. It is a logical element in the many approaches which must be followed in the attempt to obtain increased production and effect economies. We spend millions of dollars every year on research and this is accompanied by continuous trial and error. But we should not hesitate to try something new just because we cannot be sure whether it will work or not. This industry was not built by men who were afraid of experiment and venture. As you know, we at Bethlehem are experimenting with the so-called "H-Iron" process for reducing iron oxide to metallic iron in a single step, using high pressure hydrogen. We do not think this process is going to render the blast furnace obsolete, but we intend to explore its possibilities fully.

If we should not be afraid to experiment, we should not expect miracles, either. For the most part, the economies we effect and such improvements as come into being, will in the main be due to the accumulated value of many undramatic little things which become highly important when added together. In the open hearth, for example, attention to small details is very important in increasing production. An example which comes to mind is our Johnstown plant where 21 furnaces have had monthly plant capacity raised from 140,000 to 210,000 tons.

This increase was obtained through larger heat size, higher heat input made possible by redesigned burners and changing furnace throat areas, by changing reversal times, by an increase in slag pocket volume, by a change in some of the refractories and by setting up more efficient standards and operating procedures.

"Always more production," through better raw materials, better techniques, new techniques and refinements on old ones. That remains our goal as operating men. But our thinking and our responsibility do not stop with the ingot, of course. The ultimate goal is finished steel products of the kind demanded and in the quantities needed. In this connection, I do not see any significant changes in the composition of our product mix since 1949, although the trend toward the production of lighter weight steels continues.

The big jump since 1949 is in the increase in the percentage of shipments represented by sheets and strip. This typifies the trend toward lighter weight steels, and the tonnages involved reveal the progress made by the industry to meet public demand. Most of the increases reflect huge investments in new mills. They evidence the fact that the industry has demonstrated its ability to be flexible and meet new phases of public demand as they came along. However, larger tasks loom ahead.

When I met with you seven years ago, there was still a degree of uncertainty as to our ability to utilize fully the new capacity then building and projected. The possibility of a post-war slump was still receiving serious consideration. We were acutely conscious of costs and more than a little apprehensive that our expensive additions to basic and finishing capacities might fetch up idle. Today we look at things from a different perspective.

To be sure, cost is just as important an element as it ever was. In fact, more so. But it has become increasingly clear that, barring some inconceivable developments in the national economy, the problem will be to keep pace with demand. We can see now what was not too obvious back in 1949, namely, that the growth of population, plus the increased per capita consumption of steel that goes hand in hand with better living

standards, is going to require continuing expansion, and probably at increasingly heavy cost.

The Sparrows Point plant typifies developments which have taken place in the industry. This plant, with an annual capacity of 600,000 ingot tons when Bethlehem took over in 1916, has grown to a 6,200,000-ton giant. That is sizable growth for a 40-year period, but what has taken place in the recent past is equally impressive.

When this group was last in Baltimore, we had eight batteries of coke ovens. Today we have eleven in operation, with No. 12 under construction. In 1945, we had eight blast furnaces in operation. We now have nine, with No. 10 underway. Six of the furnaces in operation then have had their hearth dimensions increased. We are also moving in the direction of further increase of existing furnace capacity by preparation of the ore burden, through screening and sintering. We now have two sinter machines operating, with two more scheduled to come in this month, and another two expected to be in operation by the end of the year. You can see that our iron-making capacity has had a sizable boost since you last visited the plant.

Similarly with the open hearth departments. We are still operating 28 furnaces, but whereas their capacity was 4,666,000 net ingot tons in 1949, it is now 6,200,000 tons. This was accomplished by enlarging heat size in No. 3 and No. 2 (the latter taps 390-ton heats through bifurcated spouts) and by the introduction of desulphurized coke gas and tar as fuel. You are of course familiar with the fact that we are adding seven new 350-ton open hearth furnaces in the process of a basic expansion that will bring the plant's annual ingot capacity to some 8,200,000 tons.

To bloom the additional capacity already achieved, we have rebuilt practically all of the soaking pits. By removing every second division wall we have gained significant soaking capacity. To add blooming mill capacity we changed the stand of the 46-in. mill and made it 54-in., so as to roll wider slabs. And at the 40-in. mill we added two additional billet stands so we could take a larger bloom size off the mill. These two mills, plus a 40-in. universal slabbing mill are blooming the entire ingot output, plus ingots shipped in from Steelton and Bethlehem.

On the finishing front, we have today a capacity for 4,620,000 net tons of bands on our 56- and 68-in. strip mills. This compares with 3,000,000-ton capacity in 1949. This increase in hot rolling capacity has been achieved principally by adding heating capacity and slab handling facilities. At present, we are adding capacity that will bring us up to 430,000 tons of bands a month, principally by installing additional cranes for reducing repair time, plus additional heating capacity which will involve rebuilding all eight furnaces to permit burning substantially more fuel.

Since I last met with you, we have also added to our cold sheet and tinplate production, through the installation of a new four-stand 66-in. cold reduction mill and a fifth stand to the 56-in. cold reduction mill. We have also added three continuous galvanizing lines for sheets, bringing capacity up to 23,000 tons a month. In 1949, we had three electrolytic tinplate lines. Numbers 4 and 5 followed soon afterward. Numbers 6 and 7 have been put in within the past year. Under construction now for further tinplate production are a five-stand, 48-in. cold reduction mill, four continuous annealing lines, two skin pass mills and No. 8 electrolytic line. A two-stand, four-high 160-in. plate mill will replace the 110- and 160-in. sheared plate mills. The new mill will have a capacity of some 25,000 to 30,000 tons monthly in excess of the combined capacities of the two mills it will replace.

In addition to these changes, of course, we are replacing our lap-weld pipe mills with an electric-weld mill capable of turning out pipe in size ranges from 4 to 16 in.

That, in brief, is what we have been up to at the Point. I believe it is reflective of what the industry as a whole is doing. That is more and more capacity, and more and more production from capacities in being.

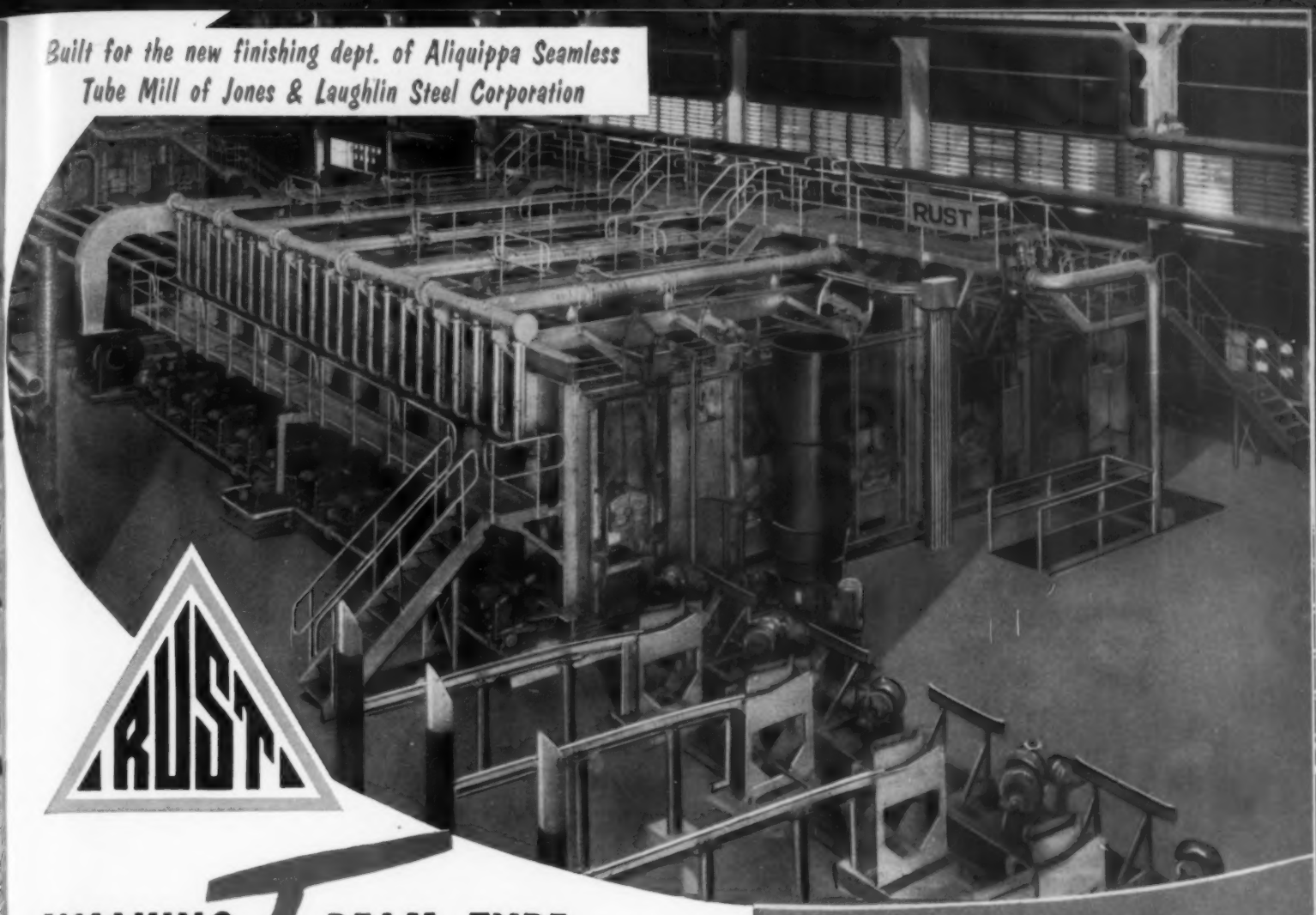
Even if the commercial market did not require this expansion, we have only to look at what those on the other side of the Iron Curtain are doing to see that we must keep pace. The expansion planned by the free world by the end of this decade is about 53,220,000 tons, or a rise of about 23.3 percent. Adding Russia's plans to those of China and Eastern Europe, the Red bloc would expand by 33,900,000 tons or 49.3 percent in four years. The capacity of the Red bloc would thus be increased to 102,790,000 tons from the present 68,-890,000. When you consider the utterly ruthless way in which this capacity can be turned to military use, without regard to the needs of civilian populations, the necessity for maintaining our margin for security purposes becomes obvious.

To keep pace with our increase in population and with the continuous advance in our standard of living, and to keep the nation safe, we must expand. But the industry as a whole is faced with the fact that it cannot finance this expansion on the basis of present earnings. We are in something of a dilemma. To meet the expanding demand at present labor costs we must install higher speed mills to replace obsolescent ones now in operation. We cannot afford not to. But how to raise the sums for this necessary expansion poses very grave problems.

I do not intend to explore the ramifications of the financing problem at this time. It is sufficient to take note that we have a real problem on our hands, and to observe that the men in this room have a great contribution to make to its solution. More and better steel at minimum cost is our far from simple assignment. Let me repeat what I said to you seven years ago tonight: "For the future, I believe that at least for your lifetime and mine the steel industry in the United States is going to keep on growing. The obstacles are tougher than they used to be, but they will be overcome."

Well, the obstacles have become tougher, but I have no less faith today than I did then that they will be overcome. In large part, the responsibility devolves on those of us in this room. It calls for leadership and understanding if we are to utilize efficiently the human resources which are fundamental to the enterprise. The steel industry today is confronted by a massive challenge. I am sure that the industry's response will measure up to the size of the job ahead.

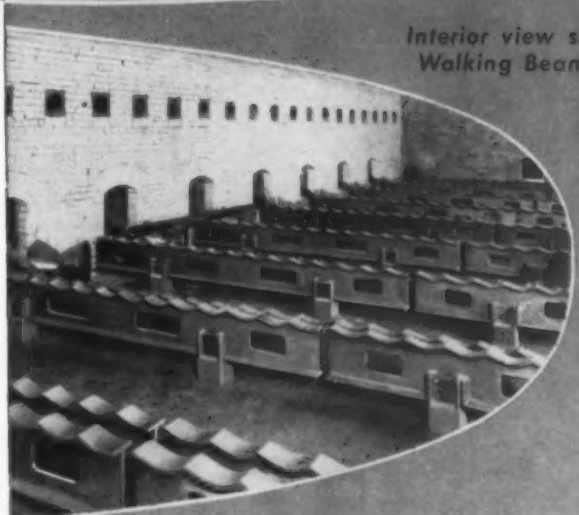
Built for the new finishing dept. of Aliquippa Seamless Tube Mill of Jones & Laughlin Steel Corporation



WALKING BEAM TYPE HEAT TREATING *Furnaces*

For heat treating their seamless tubing, the Jones & Laughlin Steel Corporation chose two specially-designed Rust furnaces as shown above. These walking beam type furnaces were designed and constructed by Rust in record breaking time—and they are helping the new "J & L" Seamless Tube Finishing Department to break records in producing, conditioning, and finishing high tensile strength seamless tubes.

Be sure to consult Rust on any problem of tube and pipe annealing, heat treating, and processing. Rust also designs and builds other type furnaces to meet every metallurgical heating need.



Interior view showing Walking Beam Rails

FIRST* *installation of this type for Normalizing, Quenching and Drawing of Seamless Tubes*

*Walking Beam Rails designed and furnished by York-Gillespie Mfg. Co.

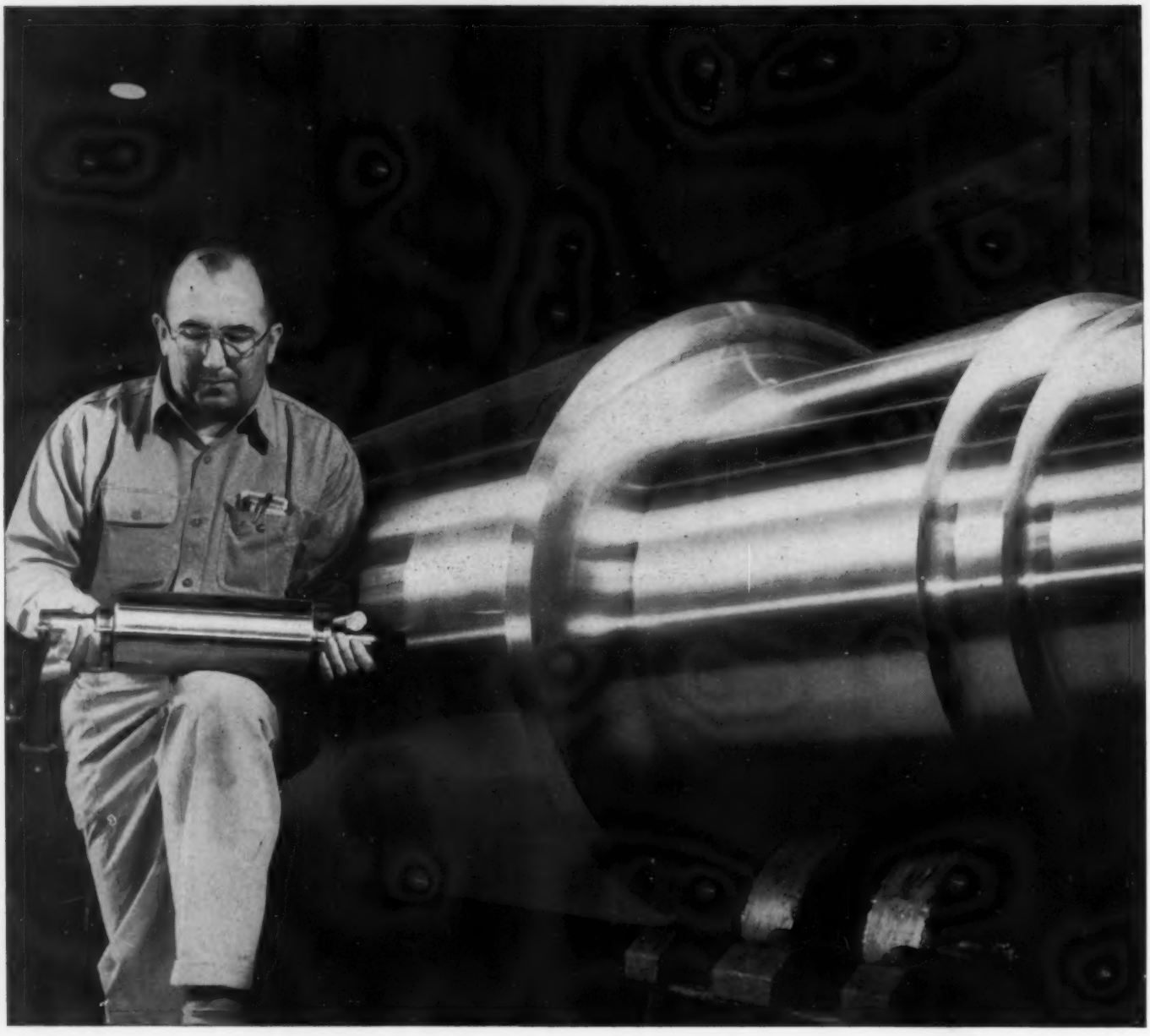
THE WHOLE JOB IS ONE JOB WITH A "RUST PACKAGE CONTRACT"

One contract covers everything, from original idea to start-up. One responsibility for design, manufacture, erection and initial operation. One overhead and profit (with substantial savings to you) on all phases of the work, including wiring and piping.

Rust Furnace Company

Pioneers in Furnace Design

Rust Building • Pittsburgh, Pa.



Poundage and Tonnage in Forged-Steel Rolls

When considering steel rolls, mill men sometimes think of us in terms of tonnage only. But, as this photograph attests, not all of the rolls we produce are of awesome dimensions. Some, in fact, are so small that their weight is less than a hundred pounds.

That little one across the shopman's knee is a case in point. It wouldn't weigh a hundred pounds wringing wet. But it's proof of the old saying that good things come in small packages. Note the beautiful workmanship from end to end.

At Bethlehem, however, quality also comes in big packages. One example would be that second roll in the photograph. It is a giant that took many weeks to create. At every step along the route, it was given the most exhaustive inspections and tests. Finish-machined it weighs upwards of 22 tons, and its quality matches its size.

You'll find Bethlehem forged rolls dependable, no matter what the size or type. They are recommended for cold-rolling ferrous sheets and strip . . . running-down and finishing operations on copper and brass sheets. . . hot- and cold-rolling aluminum sheets . . . cold-rolling aluminum foil.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

New Instrument Measures and Analyzes Sound

▲ A new electronic instrument to aid the fight against one of the country's most troublesome safety problems—industrial noise—was introduced recently by Mine Safety Appliances Company, Pittsburgh.

The instrument is the first that combines in a single, portable unit four principal functions necessary to measure and analyze noise accurately. Acoustical engineers, industrial hygienists, safety directors, industrial designers, audiologists, city planners, speech experts and many others concerned with the problem can use the instrument to track down and measure hazardous noises.

Called the "Soundscope," the instrument serves as a meter to measure overall sound levels. It also operates as an analyzer, measuring sound in each of eight octave bands to determine noise peaks. In addition, it can check sounds in narrower frequency bands. Electrical and acoustical calibrators are built into the unit.

The 20 lb instrument takes the place of four individual units previously required for noise analysis. It is expected to play an important part in efforts to control noise, which the American Standards Association reports has resulted in $2,000,000,000 worth of claims being filed against industry.

Overall noise level measurements provide little indication of what specific frequencies are causing the problem. A single industrial machine can produce sounds of many different frequencies with widely varying intensities. Each frequency band must be studied individually to locate the potentially harmful noise source so corrective action can be taken.

Because all sound is a form of energy, intensity or loudness depends on the amount of energy used to produce the sound wave. The size of the surface radiating the wave also is a factor in sound intensity.

What makes the industrial noise problem so complex is the human factor. While noise intensity and frequency can be measured, the effect on human hearing is governed by variables of age, physical condition, duration of exposure and other elements.

With the new M-S-A Soundscope, it will be possible to make noise contour maps of industrial areas. Sound level readings and analyses of frequencies and intensities at different distances from noise sources can be used to plan a detailed map of an area indicating unsafe locations.

Three measures are possible to safeguard against occupational loss of hearing:

1. Elimination of noise at the source by redesigning machinery and equipment.

2. Isolation of noise by insulation and structures.

3. Personal protection of individuals exposed—scientifically designed devices are available for this purpose. A new line of over-the-ear cushions recently was introduced by Mine Safety Appliances Company to complement the firm's lightweight insert type devices that fit into the ear canal and reduce the level of noise. These inserts, called Ear Defenders, were developed nearly 20 years ago.

To determine whether a noise hazard exists and to locate the sources are the functions of the new Soundscope. Circuits and instrumentation of the unit meet pertinent specifications of the American Standards Association for sound level meters and analyzers.

Each of the 14 tubes is mounted on a shock-absorbing pad and the first tube in each amplifier unit is encased in a metal shield. Sub-miniature vacuum tubes are used, along with printed circuits, to reduce the size of the instrument as well as to prolong the service life of the seven dry-cell batteries that supply power.

The entire instrument measures 16 in. long, 7¾ in. wide and 7 in. deep. It is enclosed in a wood and aluminum case that serves as a mechanical and electrical shield. All control dials are located on one panel and readings are indicated by a single meter.

When used as a sound level meter, the Soundscope picks up noise through its microphone which transforms sound into electrical energy. The sound pressure level is measured by passing the electrical signal through attenuators and amplifiers to the meter. The reading appears on the meter calibrated in decibels (re 0.0002 microbar).

Measurement range is from 24 decibels, about that of a very quiet home, to 150 decibels which is considerably higher in sound pressure than an air raid siren. The relative energy between these two extremes is far greater than the numerical difference in decibels indicates. A 60-decibel reading, for example, is equivalent to one million energy units while 120 decibels is comparable to one trillion—a million times greater. An increase of only three decibels in sound intensity more than doubles the vibrational energy of noise reaching the ear.

In the analyzer section of the instrument, noise is filtered into any of the eight principal octave bands, from 75 cycles to 19,200 cycles per second. Noise peaks in each of these bands then can be measured individually. For finer analysis, by frequencies within the octave bands, continuously variable filters are used.

Importance of breaking sounds into frequencies to measure intensity levels is based on investigations which show that the ear is more susceptible to some frequencies than others. Thus, technicians can accurately determine the offending frequencies.

Figure 1 — The Soundscope is 16 in. long, 7¾ in. wide and 7 in. deep. All the necessary control dials, jacks for attachments and the single meter are on the top panel. Case of wood and aluminum serves as a mechanical and electrical shield.

"We found by actual tests that FUSETRON dual-element FUSES would eliminate Motor Burnouts on our Welders"

"Here are the facts . .

"In 1946 we were having trouble with single phasing and subsequent burnout of our 3-phase welders. Motor repairs and replacements, plus the down-time was very costly.

"Could this situation be corrected, we wondered, by individually protecting each welder with Fusetron fuses?

"We ran our own test to find out. On 400 ampere welders — 3 pole fuse blocks were mounted in a steel enclosure. 80 ampere, 250 volt Fusetron fuses were installed on the load side of the enclosure.

"The circuits were then single phased. On every test the Fusetron fuses opened in 21 to 23 seconds.

"On checking further with a hook ammeter we found the locked rotor current to be 325 amperes.

"As a result of these tests, we protected all 62 welding machines with Fusetron fuses in the proper motor protection sizes.

"Sure, since then we have blown a number of fuses — but we have not had one motor burnout due to single phasing. Fusetron fuses have certainly cut costs for us.

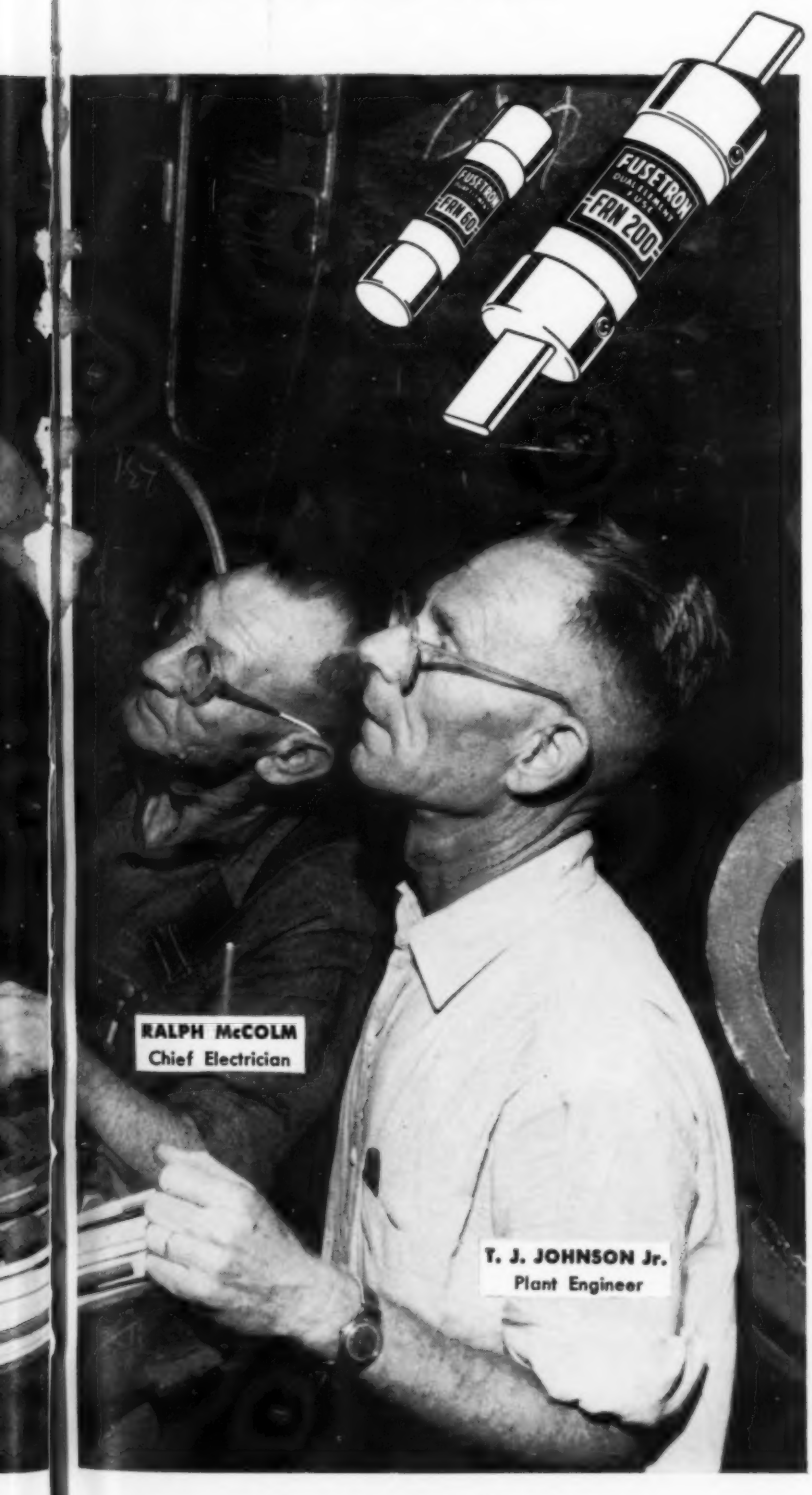
"Today, there are 147 welding machines in operation and each is protected with Fusetron fuses."

Ralph McColm
CHIEF ELECTRICIAN
BLACK SIVALLS AND BRYSON, INC.
OKLAHOMA CITY, OKLA.

why Fusetron Fuses can protect motors against burnout

Fusetron fuses have a tremendous time-lag. This means, on normal installations, Fusetron fuses can be used in motor-running protection sizes — without opening on motor-starting current or other harmless overloads.

When so used, Fusetron fuses protect motors from any harmful excess of current caused by such things as single phasing, overloading, wrong voltage, being stalled, lack of oil, tight belt, worn bearings or anything that causes the motor to draw a dangerously excessive current.



Fusetron Fuses provide simplest way to prevent damage from single phasing

When single phasing occurs, the current in the remaining phase increases about 100%. (Theoretically 73%, but change in efficiency and power factor makes it about 100%).

This 100% overload on Fusetron fuses of motor-running protection size opens them and stops flow of current to the motor.

FUSETRON FUSES DO MORE THAN PROTECT MOTORS AGAINST BURNOUT

They provide 10 Point Protection

1. High interrupting capacity — protect against heaviest short-circuits. Have proven on tests to open safely on circuits set to deliver in excess of 100,000 amperes.
2. Protect against needless blows caused by excessive heating — lesser resistance results in cooler operation.
3. Protect against needless blows caused by harmless overloads.
4. Provide thermal protection — for panels and switches against damage from heating due to poor contact.
5. Protect against waste of space and money — permit use of proper size switches and panels.
6. Protect motors against burnout from overloads.
7. Give DOUBLE burnout protection to large motors — without extra cost.
8. Protect motors against burnout due to single phasing.
9. Make protection of small motors simple and inexpensive.
10. Protect coils, transformers and solenoids against burnout.

More information on Fusetron dual-element fuses is available. Write for bulletin FIS.

FOR LOADS ABOVE 600 AND UP TO 5000 AMPS. — USE BUSS Hi-Cap FUSES!

On 600 volts or less, they have interrupting capacity sufficient to handle any fault current regardless of system growth.

They can be coordinated with Fusetron fuses on feeder and branch circuits to limit fault outages to circuit of origin.

Write for bulletin HCS.

Play Safe! *Install FUSETRON dual-element Fuses and BUSS Hi-Cap Fuses throughout entire Electrical System!*

BUSSMANN MFG. CO. FUSETRON BUSS Div. of McGraw Electric Co.

University at Jefferson, St. Louis 7, Mo.

Graphite-Impregnated Plastic Provides Lifetime Lubrication on Rapper Units

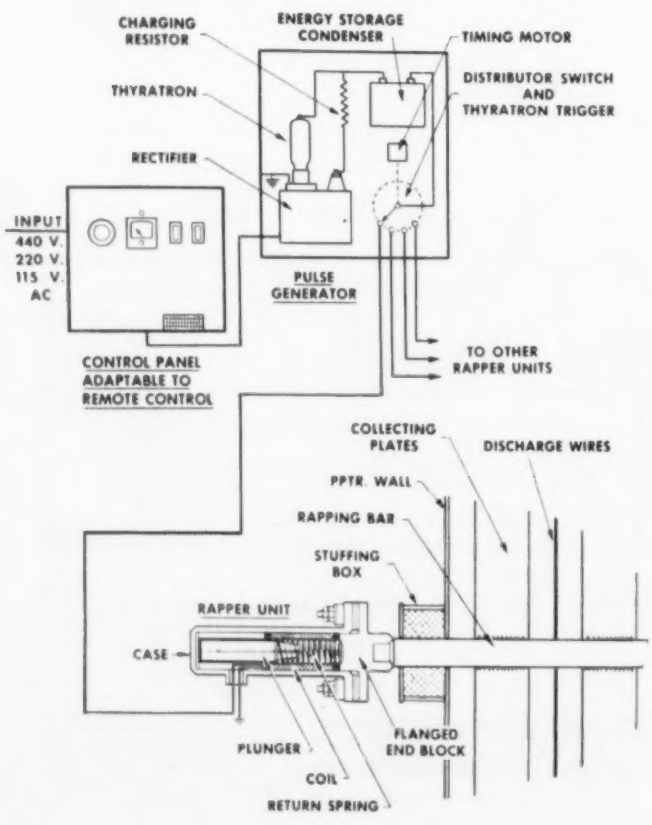
▲ THE creation of a graphite-impregnated laminated plastic material by the Synthane Corp. of Oaks, Pa., helped to turn Research-Cottrell, Inc.'s development of improved electrostatic precipitation rapping equipment into a practical reality.

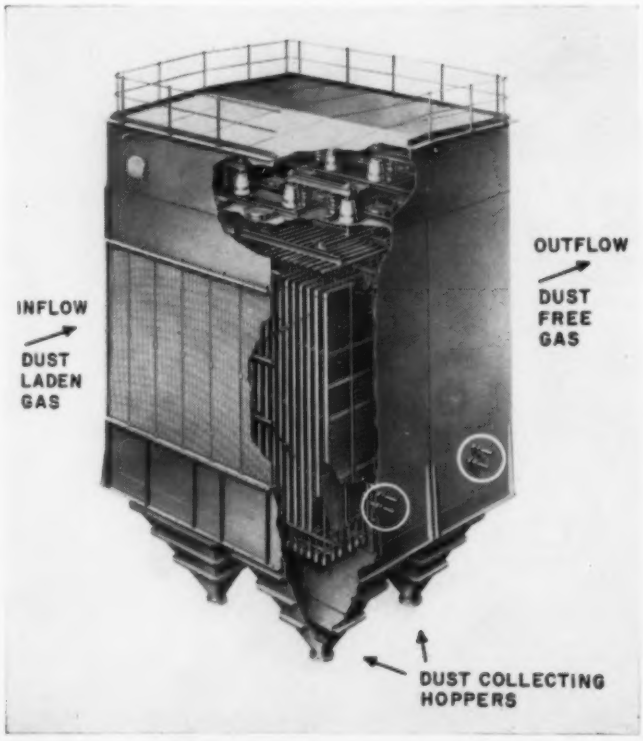
The new electronically controlled rapper system (Figure 1) provides small, frequent electromagnetically-applied rapping impulses. These impulses continuously remove the collected dust from the collecting plates into a hopper and thus prevent the formation of a thick, collected-dust layer on the plates, which stirs up dust clouds when broken off. The new system thus completely eliminates puffs of dust from the stack.

A considerable problem in the development of the new rapping equipment was the need of producing a hermetically sealed electromagnetic hammer that would apply rapping pulses at controlled intervals to the collecting plates and thus produce continuous removal of the accumulated dust from them.

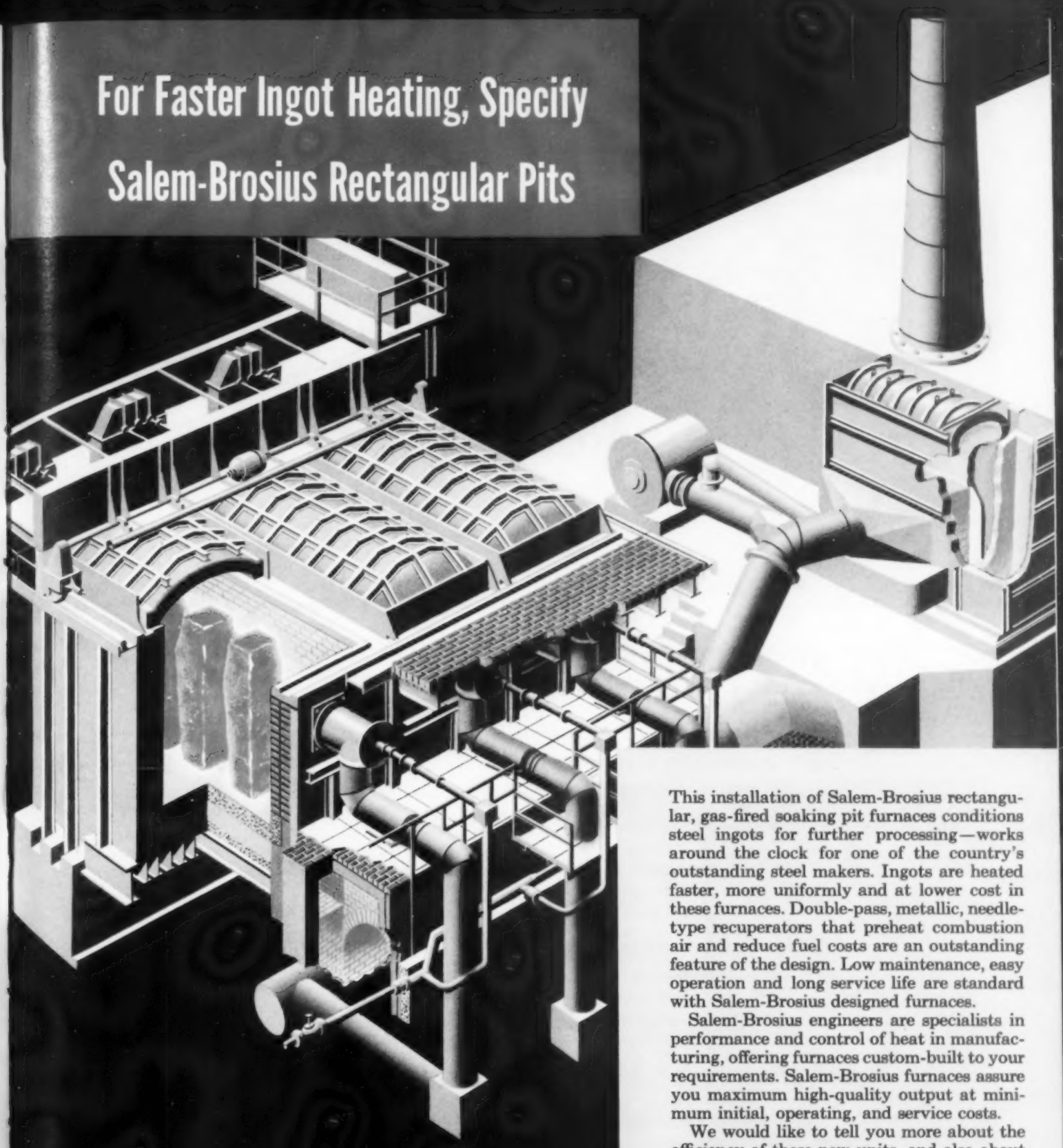
The frequent blows of this sealed-in hammer required that it be lubricated permanently at the time it was built. Also, the housing had to remain air tight to avoid failure of the

Figure 1 (left) — Secret of the new system is the application of small, high frequency "rapping" pulses to shake collected dust from the plates before it forms a thick layer. Amplitude and frequency of pulses are easily controlled by electronic system of electrical-current pulse generation. Electric current pulses are converted to mechanical rapper blows by means of an electromagnetic hammer that is sealed-in for protection from dust and corrosion. Figure 2 (right) — Cutaway view shows arrangement of dust collecting plates in electrostatic precipitators, and magnetic impulse rappers (circles) which provide small, frequent pulses that produce continuous removal of dust from plates into hoppers. Improved system eliminates dust clouds formed by earlier systems.





For Faster Ingot Heating, Specify Salem-Brosius Rectangular Pits



This installation of Salem-Brosius rectangular, gas-fired soaking pit furnaces conditions steel ingots for further processing—works around the clock for one of the country's outstanding steel makers. Ingots are heated faster, more uniformly and at lower cost in these furnaces. Double-pass, metallic, needle-type recuperators that preheat combustion air and reduce fuel costs are an outstanding feature of the design. Low maintenance, easy operation and long service life are standard with Salem-Brosius designed furnaces.

Salem-Brosius engineers are specialists in performance and control of heat in manufacturing, offering furnaces custom-built to your requirements. Salem-Brosius furnaces assure you maximum high-quality output at minimum initial, operating, and service costs.

We would like to tell you more about the efficiency of these new units, and also about the well-known Salem-Brosius circular soaking pits.

If your modernization or expansion plans call for heating or heat treating furnaces of any kind, write, wire, or phone Salem-Brosius.

SALEM-BROSIUS, INC.

CARNEGIE, PENNSYLVANIA

IN CANADA: SALEM ENGINEERING LTD. · 1525 BLOOR STREET WEST, TORONTO 9, ONTARIO

THEY'RE OFF!

These are exciting days at Pimlico
— and at our Taylor, Kentucky Works.

Expansion plans two years aforming are rapidly nearing completion. . . . By early summer these new facilities will be "off and running", to help us make more and ever better Taylor-Made sillimanite, mullite, corundum and zircon super-refractories for your furnaces:

- Additional continuous tunnel kiln, designed to fire large and small special shapes.
- High capacity crushing and grinding media for controlled, uniform sizing of feed materials.
- Additional controlled batching and mixing equipment.
- A 35% increase in brick pressing capacity—denser brick, too.
- Completely new grinding and finishing facilities at the Cincinnati works.
- Deliveries will be faster, too.

Our thanks to you for your patience and understanding during our months of construction.

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hammer from accumulations of the ever-present dust, or from corrosion produced by the corrosive flue gases.

Research-Cottrell engineers referred the problem to Synthane Corp., of Oaks, Pa., a leading producer and fabricator of laminated plastic materials for industry. Synthane devised the following solution. The sealed hammer housing encloses a tubular structure of Synthane, a laminated phenolic thermosetting plastic. This laminated tubing provides the strength to resist the powerful, repeated impacts of a magnetic core (steel plunger) which is pulled powerfully forward every time a current impulse flows in a magnetic coil wound on the outside of the tube.

To permit the plunger inside the housing to move without friction, Synthane lined the tube with a layer of laminated plastic which is impregnated with graphite. The lubricating effect of the graphite permits the hammer plunger to slide back and forth with very little friction, thus provides built-in lubrication from the beginning to the end of the life of the sealed hammer or "rapper" unit.

By a special process, Synthane achieved a laminated plastic in which the graphite flakes are dispersed homogeneously through the entire thickness of the laminated plastic sheet. These graphite flakes are securely bonded into the plastic material, and so do not flake off after a little wear, but provide continuing lubrication even as the laminate wears down. Therefore the lining of graphite-impregnated laminated plastic provides dependable lubrication for the life of the rapper, and the rapper can be built as a sealed unit.

Engineers have found that the sealed rapper units using the graphite-impregnated plastic have given such trouble-free service that none of the units produced has ever had to be unsealed, despite the fact that in each one, the magnetic core "hammer" may move back and forth as often as 1 to 6 times a minute, or 1440 to 8640 times a day for years at a time. These units have given the same trouble-free service not only in power plants, but also in gypsum, iron cupola, open hearth iron ore sintering, and many other applications.

ELECTRONIC CONTROL SYSTEM REGULATES OVER LONG DISTANCES

▲ A new method by which industry can select from a series of 21 standard "building block" components the best electronic control system to regulate push-button manufacturing operations from remote points, has been announced by The Sparks-Withington Co., of Jackson, Mich.

Developed after four years of research, this novel method is already in use in the oil industry, in petrochemical plants, and in municipal water pumping systems providing a "brain" and a "nervous system" to control vital production operations. A number of special features make the new method unique in American industry and susceptible to broad industrial applications. The modular units are inexpensively mass-produced, are hooked up merely by plug-in units which can be expanded or regrouped by semi-specialist personnel, and utilize a single standard communications channel which can handle hundreds of control and supervisory functions even at distances up to hundreds of miles, at major economies.

Most conventional control systems for in-plant or outdoor monitoring functions require a large number of communications channels to accommodate varied or multiple functions. Also, most present systems require substantial amounts of companies' engineering staff time to install and maintain custom fabricated units.

Five standard control systems are now available utilizing the modular units: (1) automatic alarms; (2) remote metering; (3) discreet control; (4) proportional control; and (5) transmission systems. They are all complete, integrated systems with all needed components supplied, and installations can be made by any plant electrician. The systems will function over telegraph and carrier circuits and co-axial cable; and to span long distances or difficult terrain, radio and VHF, UHF, and micro-wave circuits can be used.

The Sparton systems are presently in use remotely controlling and supervising widely separated unattended high-power pumping stations in municipal water works. They are applicable to long-distance highly accurate control over petroleum and natural gas field pump lines, power generating stations, power transmission lines, chemical processing plants,

The new Sparton systems provide a "brain" and a "nervous system" to control vital production operations. Four years in development, the systems are applicable to steel mills, mines and varied process industries.

sewage systems, steel mills, mining operations, process industries, and many other types of mass-production processes where control and supervision are required for complicated machinery.

The Shell Oil Company is using the standard components to comprise two applications near Chicago to open and close pipe line valves, one from a control board 25 miles away.

By proper selection of the right pre-fabricated modular units, industries can build their own systems which are versatile enough to measure and transmit operational information to distant control centers on quantities of pressure, vacuum, speed, current, rate of flow, temperature, position, load, and count. The Sparton building block components, in properly integrated systems, will even report on the level of supplies or raw materials in a bin, vat, tank, or similar storage container.

Control features of the varied systems are sufficiently flexible to turn any type of manufacturing process on or off, regulate sequence in a factory operation, apply proportionate amounts of control, or supply step and selective controls to plant production lines.

Two main classes of systems may be provided using the Sparton modular units: completely automatic, and centrally controlled where a single operator can check the condition of a whole manufacturing process by glancing at an integrated control panel incorporating meters, indicator lights, or a variety of alarm signals.

They will control processes operated electrically, mechanically, pneumatically, or hydraulically; and they are sufficiently sensitive to regulate fractional horsepower motors as well as powerful enough to control 1,000 horsepower units or more.

All adjustments and calibrations are built into the building block units. Routine maintenance checks are required no more than three times a year and can be carried out by plant electricians merely using a test meter and logging readings which are compared to fixed performance standards.

Maintenance of the modular units is on a calendar basis with standard units simply unplugged and spares plugged in until the original unit is serviced and reinserted into the system. Recommended replacement time cycles are after 10,000 hours of service, or 415 days of use.

At present the Sparton building block technique is engineered to provide up to 125 channels of control available in the resulting systems, in a progression of 10, 25, 50, 100, and 125 channel systems.

In a normal 10-channel system, over each channel, it is possible to effect control of eight different functions. In a typical system for the petrochemical industry or a municipal water pumping station, these eight functions might operate as follows. A key is depressed at the control board and:

1. Pump turns on.
2. Signal flashes back, light turns on on control board signalling pump functioning.
3. If pump malfunctions, alarm light turns on.
4. Bearing temperatures are reported on. Four lights report on two motor bearings and two pump bearings.
5. Signal reports that pump is building up pressure.
6. Signal will report on the correct value of the pump pressure reading, or an alarm warning will sound for incorrect pressure.
7. Control order is transmitted which opens valve to any predetermined degree.
8. Can increase or decrease the open valve position in very small increments — all from miles away.

The systems can integrate memory circuits, and are flexible enough that electronic computers or punched card or punched tape activated equipment can be added.

A separate division of the company has been established, the Sparton Control Systems Division, with Harold P. Katherman appointed General Manager, to manufacture, sell, and supervise the installation of the unique modular unit systems.

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No other molded bushing can even approach the physical properties of Adalet PEGI Bushings.
STRENGTH 10,000 psi tensile
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Steel Company Hits Production HIGH SPOTS with CORHART 104 in "HOT SPOTS"

$3\frac{1}{2}$-YEAR ELECTRIC FURNACE LOG SHOWS CORHART 104 UPS PRODUCTION 37%

The graph above gives a campaign-by-campaign story of how Corhart 104 in "hot spots" upped production for a midwestern steel company. Average increase was 37% over the $3\frac{1}{2}$-year period covered by this 60-ton electric furnace log.

How much would this magnesite-chrome, electrically melted and poured refractory increase *your* production? A description of your operations will bring suggested Corhart 104 applications and costs. Corhart Refractories Company, *Incorporated*, 1624 West Lee Street, Louisville 10, Kentucky, U.S.A.

QUALITY ECONOMY ENDURANCE

CORHART 104
ELECTROCAST
REFRACTORY

The words "CORHART" and "ELECTROCAST" are registered Trade Marks which indicate manufacture by Corhart Refractories Company, Incorporated.

J&L May Enter Stainless Production Field

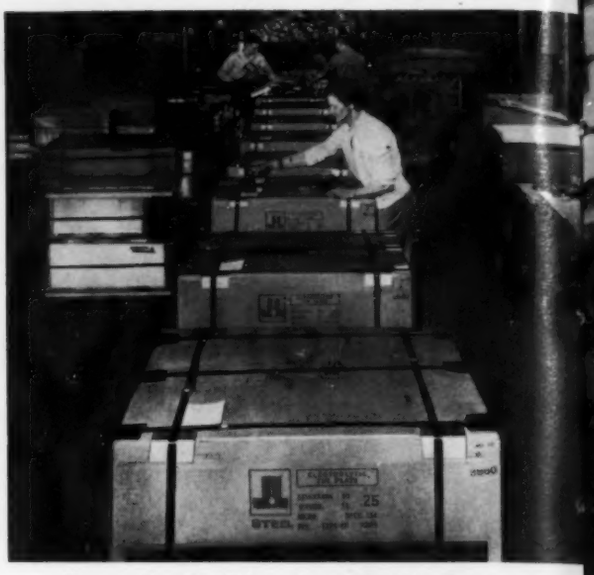


Figure 1 — In this automatic tin plate packaging conveyor line, sheets of tin plate are swiftly boxed by hydraulic banding machines and prepared for shipment. An "electric eye" activates the conveyor line as the boxes are removed by lift trucks.

▲ J&L management told their shareholders at their annual stockholders meeting on April 26 that they are seriously considering an early entrance into the production of stainless steel products. Although further details were not announced, the completion of two new electric furnaces at the Cleveland works would provide melting capacity for stainless production. Hot rolling facilities are available in the various plants, but it is believed that finishing facilities for stainless must still be authorized.

At this meeting, a number of additional details of Jones & Laughlin's $250,000,000 improvement and expansion program were discussed. The completion of the new galvanizing line at the Pittsburgh works adds a new product to the J&L line, and by the end of the year, partial production is expected on two other new products, continuous welded pipe and electricweld line pipe. This pipe will be produced at Aliquippa where two continuous weld pipe mills will replace three old hand operated mills. A new mill at Aliquippa also will produce electricweld pipe in sizes from 4½ in. to 12¾ in. outside diameter.

By the end of the year, production will be underway on the enlarged line of oil well casing and tubing.

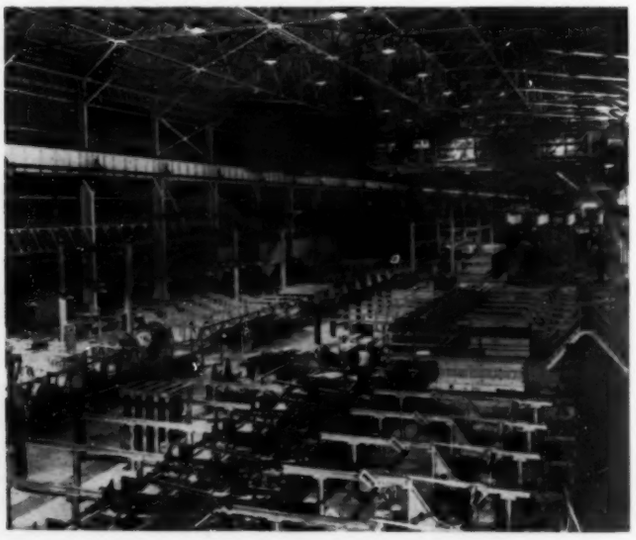
The schedule for production of steel by the oxygen-converter process is now early 1957 at which time electric furnace production will be started at Cleveland.

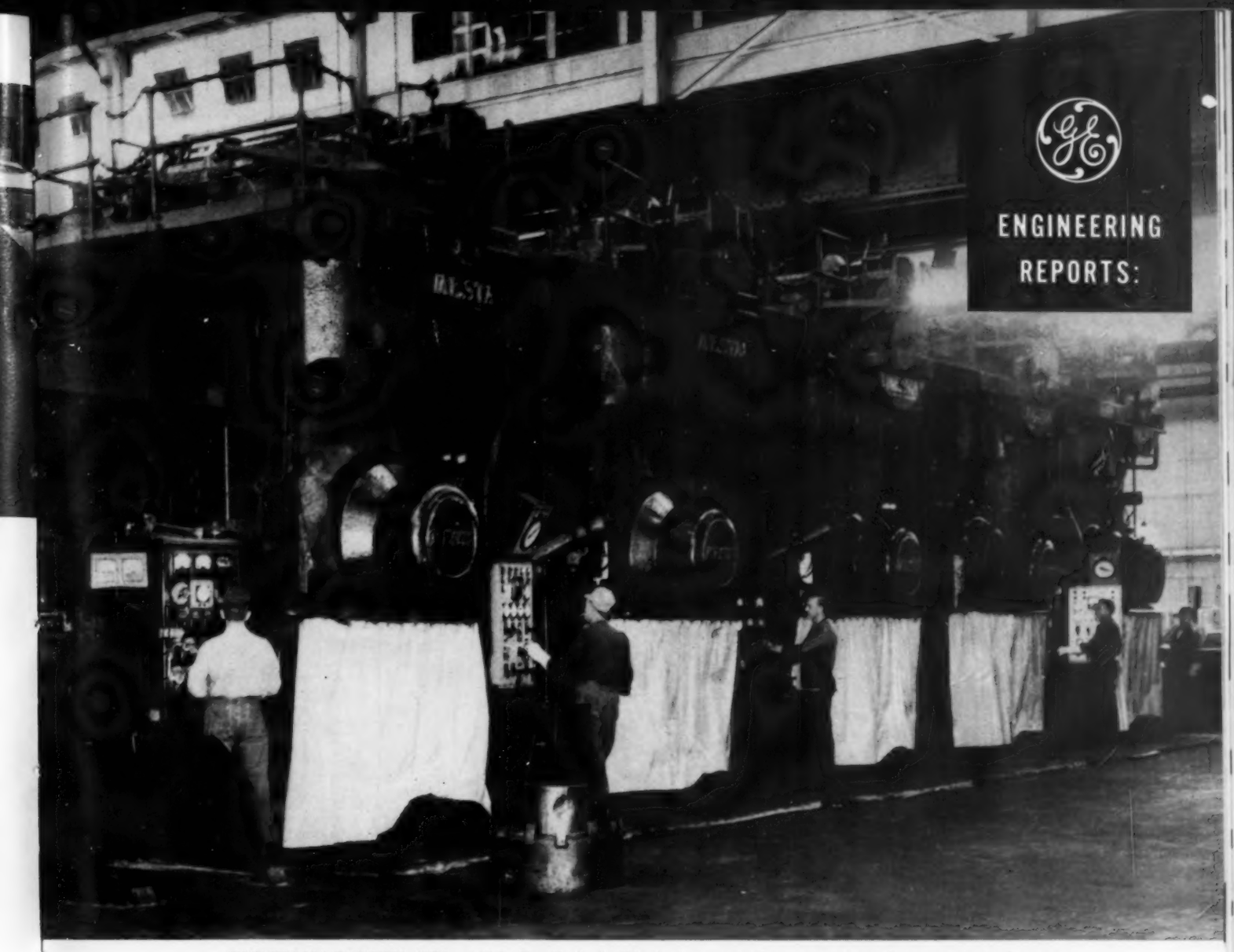
Other items on the expansion program include the enlargement of the blast furnace at Aliquippa to 28 ft 6 in. hearth diameter, and a new sinter plant at Cleveland.

Among the new rolling mill facilities are a blooming-slabbing mill at Cleveland, major improvements to the hot strip mill to produce heavier coils, and a new 4-stand tandem cold mill at Cleveland which will probably be the most powerful unit of its type (22,900 hp), and a new temper mill. A new 44-in. hot strip mill is also under construction at the Aliquippa works.

Figure 2 — This new tin plate shear is one of the improvements at the Aliquippa works. The shear, a three-pile box type, assures top grade tin plate by means of an electric eye and automatic X-ray micrometer. These devices permit speeds up to 1000 fpm by the new shear.

Figure 3 — Nearing completion are these pipe finishing facilities in the seamless tube specialties department at J & L's Aliquippa works. The seamless tube specialties department produces high strength tubular products for deep well drilling.





FIVE-STAND TANDEM MILL at U.S. Steel's Irvin Works incorporating an automatic gage control system

At U.S. Steel: NEW G-E Automatic Gage Control Improves Steel Strip Quality

An automatic gage control system for closer, continuous control of cold reduction mills producing sheet and strip products, has been developed through the co-operative efforts of the United States Steel Corporation and the General Electric Company. The system, now in use at U.S. Steel's Irvin Works, Dravosburg, Pa., improves the thickness uniformity of cold-rolled steel strip produced at a rate up to 4000 fpm.

The increasing application of high-speed continuous sheet and strip mills in the steel industry emphasized the need for automatic control of thickness. To solve the problem, a joint research and development study of cold reduction mill controls was instituted by United States Steel and General Electric.

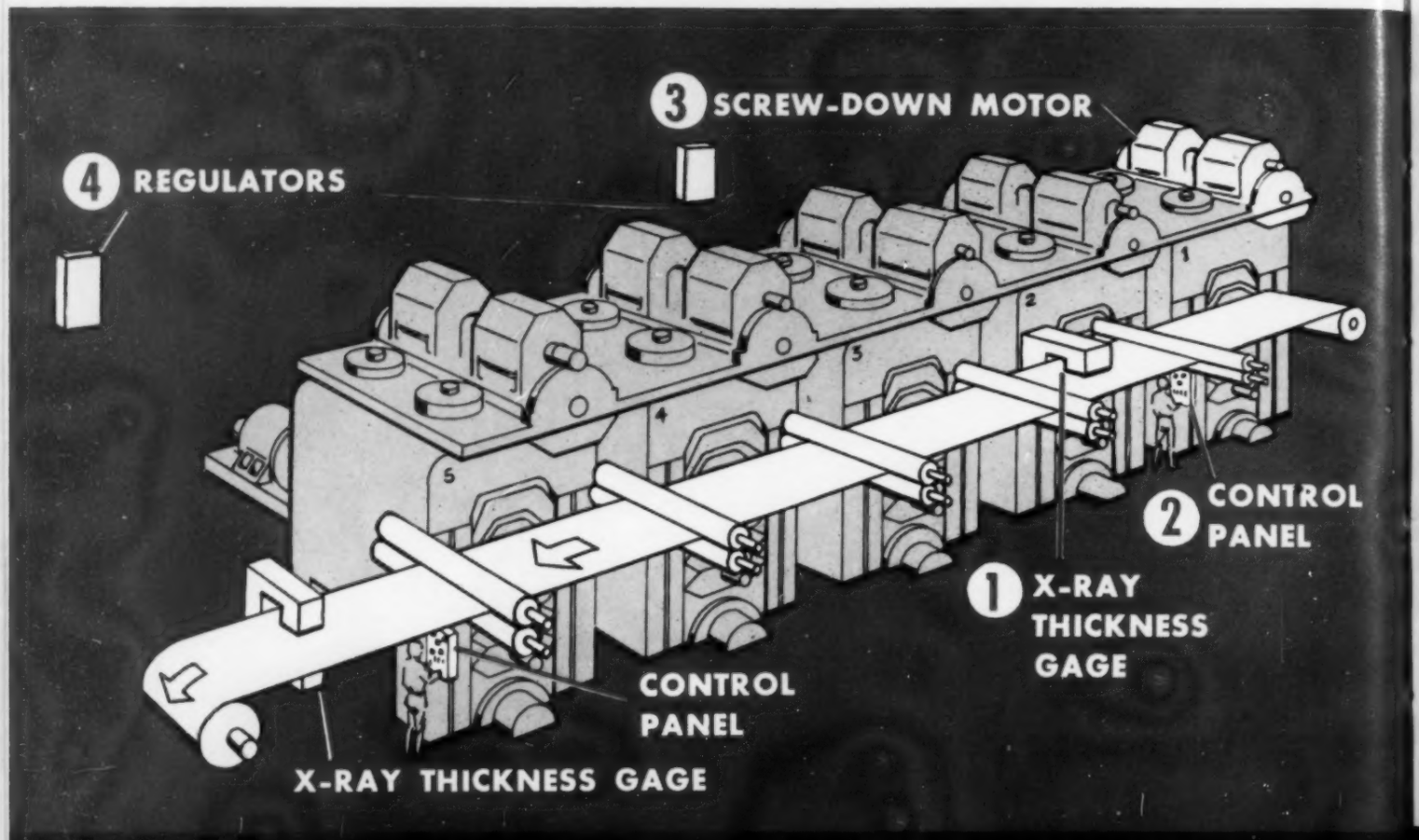
Before attempting to design any system, G-E application engineers set up the problem on an "electronic brain" for study of the complete mill thickness problem and drive system. The analysis took into account all electrical constants, changes in roll pressure and interstand tension. Components of the resulting system design were constructed by G.E.'s Industry Control and X-Ray Departments.

This new installation is the first over-all thickness control in the steel industry to utilize not only a screw-down control to vary stand 1 reduction, but also a vernier system operating on the roll speed of the last stand. With this arrangement, thickness variations in the finished product can be held smaller than was ever possible by manual means.

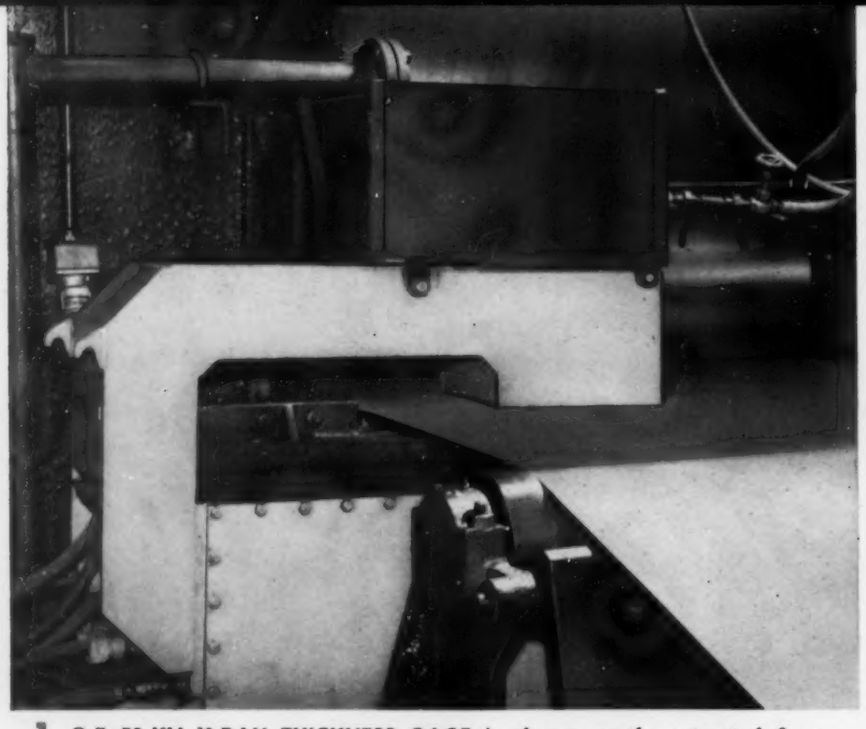
TURN PAGE FOR SYSTEM STORY

GENERAL ELECTRIC

G-E system automatically controls steel



SYSTEM-DESIGNED COMPONENTS



1 **G-E 50-KV X-RAY THICKNESS GAGE** is shown partly retracted from gaging position. Each gage is mounted on a truck which retracts gage for servicing and maintenance.

2 **THE TWO OPERATORS'** control cabinets contain the controls and instruments to set up and observe drive system functions.

strip thickness, permits closer tolerances

The x-ray gage system actually operates as a "watch dog" during the rolling of the strip and is integrated into the rolling process as shown in the illustration at left.

Here's how it works: Control of stand 1 originates in an x-ray gage between stands 1 and 2. The strip passes between the x-ray unit and a detector unit. The desired thickness of the steel sheet is set on a dial of the gage. The actual thickness of the steel is then measured by the x-ray gage, and deviations from the desired thickness are brought to the automatic control panel in the form of an electrical signal.

This signal activates a transistor discriminator in the automatic control which determines the direction of the error, whether heavy or light, and also the degree of the error. The discriminator emits a signal which is fed into on-and-off time circuits. The resulting signals then operate the up and down relays of the stand 1 screw-down motors, which run in the required direction to correct the steel thickness.

A 50-kv x-ray thickness gage similar to the one used between stands 1 and 2 measures and initiates control of the thickness of the strip leaving stand 5 before it is wound on the reel.

On this mill the stand 5 direct current mill motor receives its power from a common source which also supplies power to the other mill stand motors. Stand 5 speed can be varied automatically in relation to previous stand motor speeds, thus adjusting the thickness of the material leaving stand 5 through variation of tension between stands 4 and 5.

In actual operation, mill is set up manually by operators. Coarse and vernier settings of the motor-field current regulator of the gage system are then set to approximate desired output thickness. During rolling the regulating systems are continuously in control of product thickness and make corrections for all deviations.

This new automatic gage control system was designed to provide a better product, minimize waste due to off-gage material, augment skill, experience and knowledge of the head roller and relieve crew members of adjusting manual controls.

If you are planning to build, modernize, or expand your facilities, the same G-E "know-how" which went into this system is available to you. For further information contact your local G-E Apparatus Sales Representative. General Electric Co., Schenectady 5, New York. 639-112

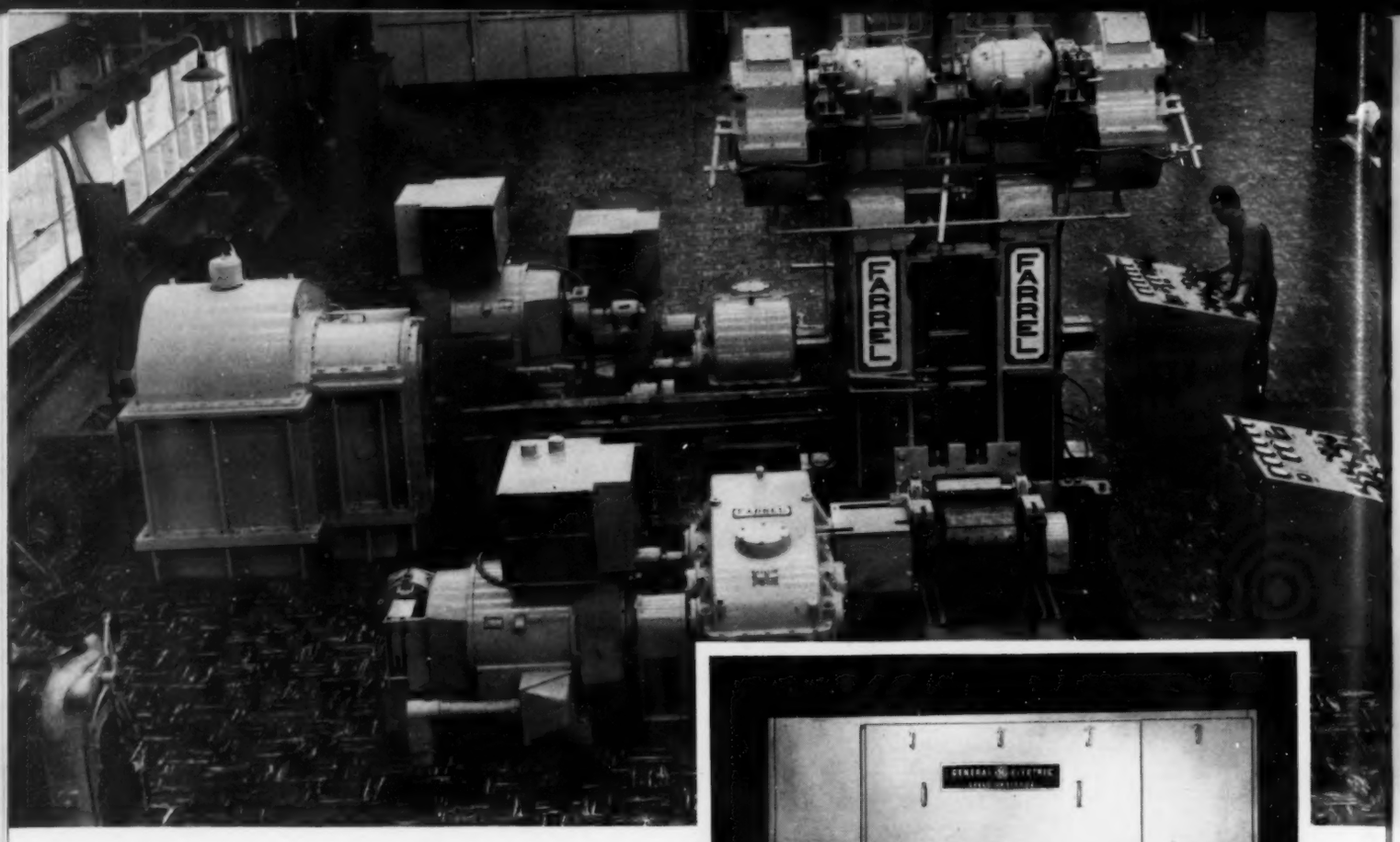
Engineered Electrical Systems for Steel Mills

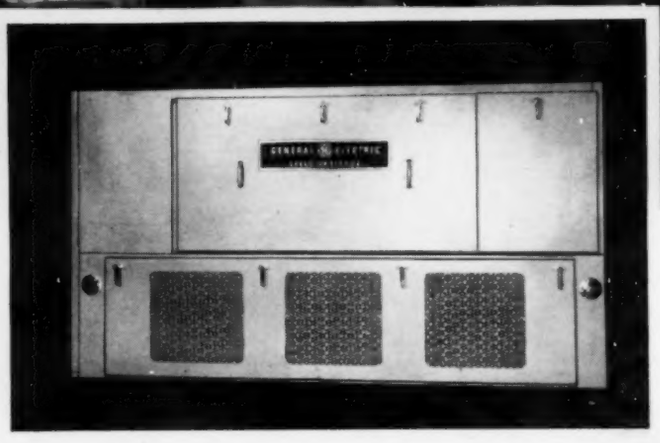
GENERAL ELECTRIC

INTEGRATE ROLLING PROCESS

3 THE SCREW-DOWN MOTORS on stand 1 operate as an integral part of the automatic gage control. A screw-reset function automatically returns the screws to their initial position after the coil tail-end leaves the mill.

4 THE REGULATING SYSTEM was designed on the basis of transistor and magnetic-amplifier techniques and components.





Controlled d-c power for this development laboratory reversing cold strip mill is supplied entirely from G-E Speed Variators. The main m-g set and controls are housed in compact steel cabinets (right), requiring no foundation. These packaged units are engineered to meet your special requirements.

NOW AVAILABLE FROM GENERAL ELECTRIC

Packaged Speed Variators Built to Large Rolling Mill Standards

COMPLETE ENGINEERING APPLICATION SERVICE TO MEET YOUR SPECIAL REQUIREMENTS

Built to large rolling mill standards, General Electric Speed Variators are now available for special drive applications up to 500 hp. Using circuits originally developed for large rolling mills they offer close, accurate control with great reliability and high overload capacity.

Complete engineering services offered for large mill installations are available with Speed Variator applications. G-E specialists will arrange operator's control station or desk layout to meet your special requirements. Regulating equipment can be adapted to various rolling mill characteristics. For example, this reversing cold strip mill can be used as a 4 high mill with 3- or 6-inch work rolls or can be used as a 2 high mill with 21-inch work rolls.

Factory wired and tested, the Speed Variator power unit comes ready to be installed. Drive components include operator's control station, power unit and drive motors. The rugged all steel cabinet of the power unit contains m-g set and controls in a compact enclosure.

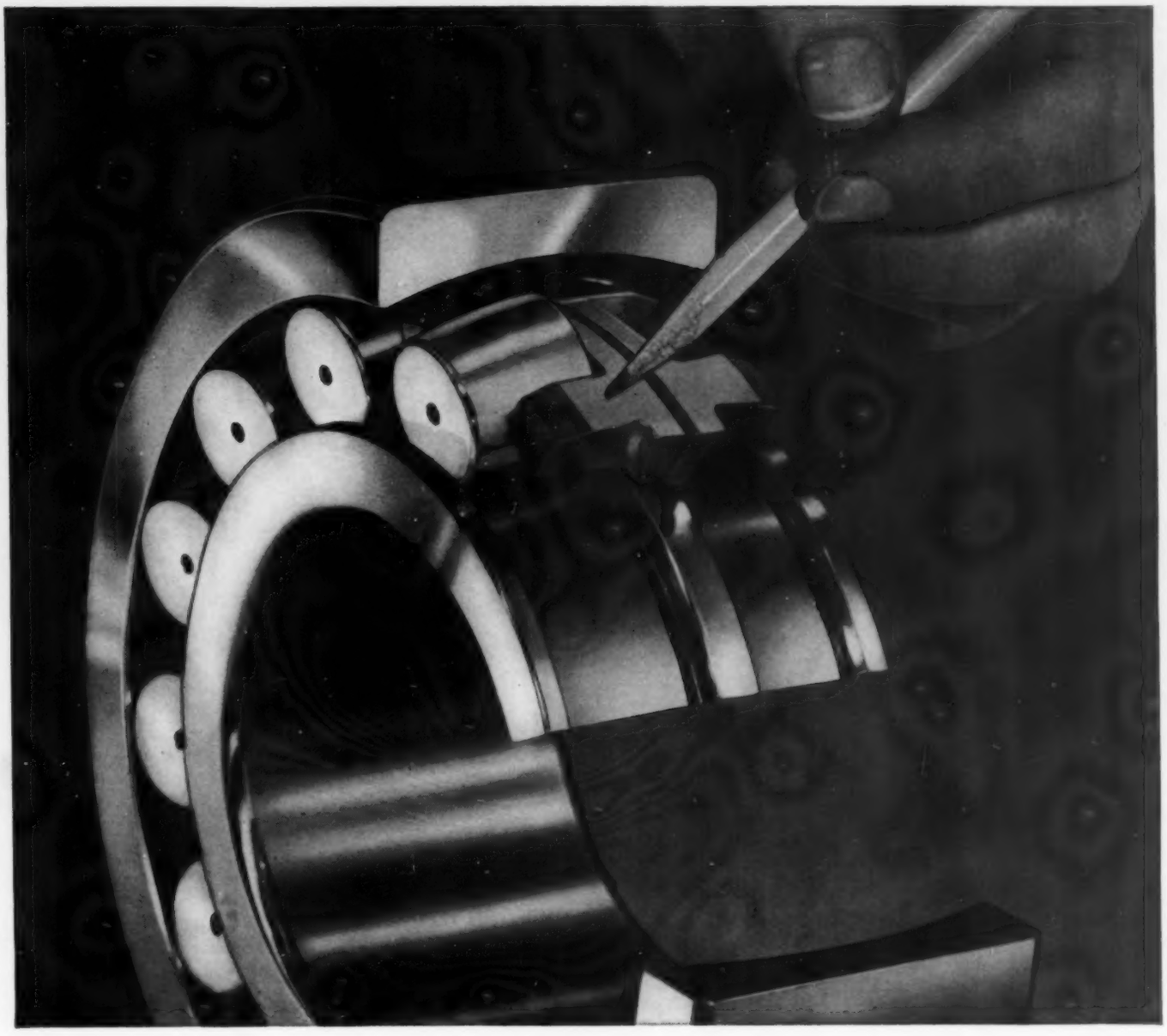
Find out how this flexible, packaged source of d-c power can be used to best advantage in your mill. G-E engineers, specialists in steel applications, are at your service. Contact your G-E Apparatus Sales Office. *Direct Current Motor and Generator Department, General Electric Company, Erie, Pennsylvania.*

820-1

Progress Is Our Most Important Product

GENERAL ELECTRIC

TORRINGTON *SPHERICAL ROLLER* BEARINGS



Land-riding cages for longer life!

These fully machined cast-bronze, land-riding cages—one for each path of rollers—are important performance builders in TORRINGTON's Spherical Roller Bearings. The one-piece retainers keep the rollers perfectly aligned at all times, even under conditions of shock load and sustained speeds. Lubrication is more effective, too, as the lubricant has easy access to vital points of contact between rollers and races.

This feature is typical of TORRINGTON's design, made possible through long experience in serving industry with the finest in precision bearings. That's why it pays to look to TORRINGTON first when your application calls for Spherical Roller Bearings. They're available from stock with either straight or tapered bore, for shaft or adapter mounting.

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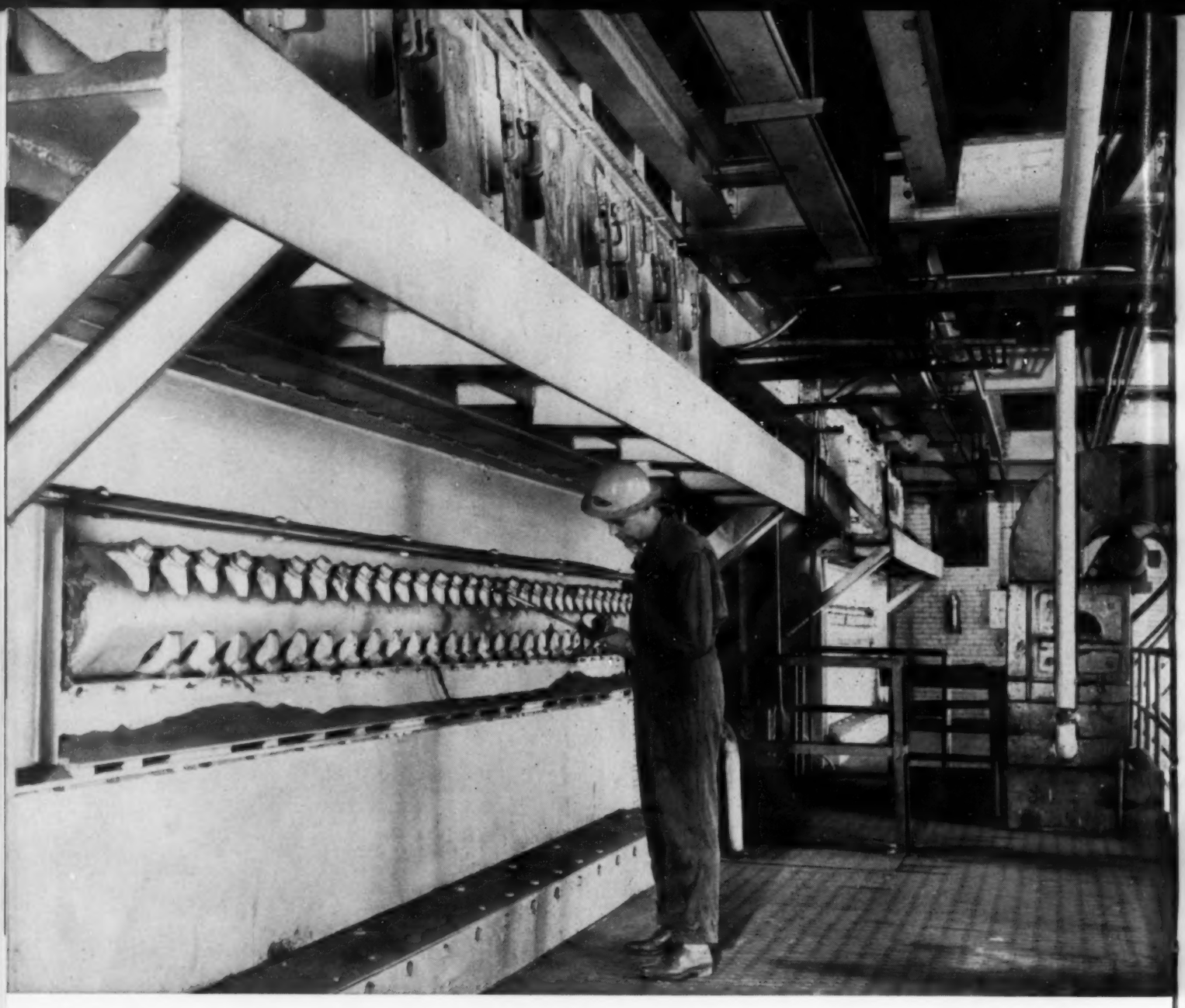


The risk is too great —clean it right

You don't take risks when men, equipment, and lost production time are involved. That's why more and more companies are investigating the methods and firms used in their chemical cleaning. They know it's work for experts.

What are they concerned about?

First, they want to know they are getting the benefits of experience. These benefits include less downtime and more thorough cleaning. Dowell has this experience with over 15 years and 10,000 boilers alone to their credit. In saving downtime, Dowell often cleans equipment while it is in operation.

Next, these companies want to be sure their men and equipment have the greatest possible protection. Dowell excels here, too. For safety is foremost in the Dowell engineer's mind. Thoroughly trained, he uses only the latest safety methods and equipment. He works closely with your safety personnel to establish safest possible working procedures.

Be sure you are getting maximum results with maximum protection in your chemical cleaning.

Call the Dowell office near you. Dowell engineers are ready to discuss and help you with your cleaning problems any time, at no obligation. Or write Dowell Incorporated, Tulsa 1, Oklahoma, Dept. E29.

chemical cleaning service for industry **DOWELL**

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

Date-line Diary...

April 2

▲ The AISI reports that the operating rate of the steel industry for the week of April 2nd is scheduled at 99.1 per cent of capacity. This is equivalent to 2,439,000 tons compared with 2,452,000 tons one week ago and 2,300,000 tons one year ago. Index of production for the week is 151.8.

April 3

▲ March's total of 575,758 cars turned out by auto makers was 3.8 per cent above February, and 27 per cent less than March, 1955. For the first quarter, the 1,700,000 cars built were 18 per cent less than a year ago.

▲ The Federal Reserve Board reported that consumer installment debt was increased by $15,000,000 in February, 1956 resulting in total installment credit outstanding of $27,800,000,000, about $5,300,000,000 more than a year ago.

▲ The government increased by 1,000,000 lb the nickel slated for use by private industry for the second quarter of 1956. This amounts to 2,500,000 lb to be diverted during this period and is the first time an increase has been granted for this use in this commodity.

April 4

▲ AISI reports payroll of the iron and steel industry during February was $317,326,000 only $11,800,000 less than January which was two days longer. Average payroll cost of wage earners in February was $2.613 for each hr compared with $2.617 in January and $2.406 in February, 1955. Working hours averaged 40.5 hr per week compared with 39.5 hr per week in January, and estimated total on payroll in February was 683,700.

▲ Prices of steel scrap in the Buffalo area have been increased about $3 per gross ton to about $53 for No. 1 scrap or to about the highest price level in history. The new prices are approximately double the price a year ago.

▲ General Electric's subsidiary, the Mahoning Valley Steel Co., announced plans to build a new $500,000 tube mill at its Niles, Ohio sheet steel mill. Work is to start immediately and completion is scheduled for late this year.

▲ Loadings of rail freight for the week ended March 31 were 724,944 cars, up 10.7 per cent over the same period last year. Class I railroads in February netted $47,000,000 compared with $46,000,000 in January and $46,000,000 in February one year ago.

▲ Chase Brass & Copper Co., fabricating subsidiary of Kennecott Copper Corp., increased its prices for copper products by 1½¢ per lb and for brass products by 0.93¢ to 1.4¢ per lb, depending on copper content.

April 9

▲ The U. S. Dept. of Commerce announced that shipments of gray iron during January, 1956 amounted to 1,250,000 short tons, approximately equal to December, 1955 total and 14 per cent above the January 1955 total. Steel casting shipments totaled 159,000 tons in January, about equal to December shipments, and 61 per cent above January, 1955 shipments.

▲ Kaiser Aluminum & Chemical Corp. announced it proposes to finance the current $170,000,000 expansion program by selling to the public $30,000,000 convertible preference stock, and the direct placement with financial institutions of 25-year first mortgage bonds in the amount of $120,000,000. An additional $20,000,000 will come from retained earnings.

▲ A plan was proposed to the Globe Iron Co.'s stockholders whereby its assets and properties, including a majority interest in Globe Metallurgical Corp., may be acquired by the Interlake Iron Corp. The plan must be approved by 97½ per cent of Globe Iron stock, as well as Interlake directors and shareholders. Plan calls for exchange of Interlake stock for Globe Iron's holdings of Globe Metallurgical stock, and of additional Interlake shares for all of Globe Iron's remaining assets. If the plan is adopted, Interlake would offer additional shares in exchange for Globe Metallurgical stock publicly held at the rate of 0.4666⅔ of a share of Interlake common for each share of Globe Metallurgical, the same rate proposed in connection with the Globe Metallurgical shares owned by Globe Iron.

▲ The AISI reports that the operating rate of the steel industry for the week of April 9, is scheduled at 98.1 per cent of capacity. This is equivalent to 2,414,000 tons compared with 2,406,000 tons one week ago and 2,284,000 tons one year ago. Index of production for the week is 150.3.

▲ The Babcock & Wilcox Co. stockholders approved a proposed three-for-one stock split resulting in an increase from 3,000,000 shares of no par value to 9,000,000 of $9 par value.

▲ The Commerce Dept. reported that personal income in February was at a yearly rate of $313,100,000,000, $400,000,000 above the January pace and nearly $20,000,000,000 higher than last year. Gains in other industries more than offset the declines in the auto industry payrolls.

▲ The Aluminum Co. of America announced that construction will begin immediately on the $45,000,000 plant to be built at Point Comfort, Texas for the production of alumina.

April 10

▲ Employment in March totaled 63,100,000 which was 500,000 more than in February, 1956 and 2,500,000 above March, 1955.

▲ The directors of the Blaw-Knox Co. will submit a proposal to increase the firm's authorized capitalization to 3,000,000 shares from 2,000,000.

April 11

▲ Government figures showed that construction outlays in March rose to nearly $3,000,000,000, equalling the record set last March, and 10 per cent above the February, 1956 expenditures. For the first three

months of 1956, the total outlay amounted to $8,500,000,000, the same as the same period in 1955; residential building was down 5 per cent, commercial construction up 21 per cent compared with a year ago.

▲ March steel production amounted to 10,921,000 tons, largest for any month in history. The first quarter output of 31,868,226 tons exceeded the previous high set in the final quarter last year, by 616,000 tons.

▲ Eugene G. Grace, chairman of the Bethlehem Steel Co., told the annual meeting that the directors of the company are giving "constant attention and consideration" to the question of a stock split. However, he added "we hold the view today that the time is not yet here."

▲ The F. W. Dodge Corp. reported contract awards for future construction in the 37 states east of the Rockies in March totaled $2,382,000,000 up 12 per cent above March, 1955.

April 12

▲ Price of refined copper for May delivery was down one cent, to 50 cents a lb; price on prompt delivery copper, off ½ cent a lb to 50½ cents.

▲ A cut back in the exportation of iron and steel scrap was urged by the House Banking Committee. The committee reported that the 1955 export total of over 5,000,000 tons was much too high and recommended that exports should be reduced to a level to insure an adequate supply of scrap for domestic needs. The Government Export Control Authority was voted to be extended for another two years, until June 1958.

▲ Consumption of scrap and pig iron during February totaled 12,214,000 gross tons, a decrease of 6 per cent from January, according to the Bureau of Mines, U. S. Department of the Interior. Scrap consumed in February totaled 6,370,000 tons.

April 13

▲ Avery C. Adams, president of Pittsburgh Steel Co. advocated steel price increases of $12 to $15 a ton to help defray inflated costs of expansion and raise the return on the steel industry's investment to an equitable level.

April 16

▲ Price of spot copper on the London Metal Exchange closed last week at 47⅜ cents a lb, down 1⅝ from the week before. Foreign producers shipped 121,364 tons of refined copper during March to users outside the U. S., 24,000 tons above February deliveries and the largest since June, 1954.

▲ The AISI reports that the operating rate of the steel industry for the week of April 16 is scheduled at 99.4 per cent of capacity. This is equivalent to 2,447,000 tons compared with 2,483,000 tons one week ago and 2,284,000 tons one year ago. Index of production for the week is 152.3.

April 17

▲ The Aluminum Assn. reported primary production of aluminum during March totaled 291,875,457 lb in comparison with 265,524,546 lb in February, 1956 and 260,543,479 lb in March, 1955.

▲ President Eisenhower vetoed the farm bill, declaring it as contradictory and self-defeating — that it further threatened the slumping farm income. The administration will, the president announced, boost price supports on wheat, corn, and rice up to 11 per cent and take other steps to increase farm earnings.

▲ A proposal will be submitted to the stockholders of the Wheeling Steel Corp. at the annual meeting, April 25, to increase to 5,000,000 from 2,000,000 the authorized common shares. A plan to end limitation on the amount of first mortgage bonds, now set at $75,000,000 will also be put before them, aggregate principal amount of these bonds outstanding at March 15 total $26,097,000.

April 18

▲ Deliveries of new domestic freight cars in March showed an increase to 5,949 from 4,881 in February and 2,833 in March, 1955 according to the ARCI. Orders in March totaled 1,618 compared with 1,675 in February. Backlog of cars on order as of April 1 stood at 137,070 cars.

▲ Aluminum Co. of America announced that work will start immediately on a new 150,000-ton, $80,000,000 smelting plant near Evansville, Ind., boosting the company's aluminum-making capacity about 20 per cent.

April 19

▲ Kaiser Steel Corp. announced establishment of base prices on tin mill products at Fontana, a change from the previous delivered basis.

▲ The President's Council of Economic Advisers advised that the U. S. output of goods and services climbed to a rate of $399,000,000,000 during the first quarter of 1956, a gain of $1,700,000,000 over the final quarter of 1955.

April 23

▲ Ford Motor reported, for the first quarter, net earnings of $1.37 per share, compared with $1.93 for the same period last year, and $2.34 for the final quarter of 1955. Sales for the first quarter 1956 were down 14.7 per cent over the same period in 1955, and dropped 22.5 per cent from the final period in 1955.

▲ The AISI reports that the operating rate of the steel industry for the week of April 23 is scheduled at 99.7 per cent of capacity. This is equivalent to 2,454,000 tons compared with 2,466,000 tons one week ago and 2,307,000 tons one year ago. Index of production for the week is 152.8.

April 24

▲ Orders for machine tools rose to $95,400,000 in March, an increase of 10.8 per cent over February, and 51 per cent over March, 1955. Shipments in March amounted to $74,000,000, 24 per cent over March a year ago.

▲ The Industrial Heating Equipment Association reported that orders received for industrial furnaces during March amounted to $7,025,034, down 4½ per cent from March, 1955. Orders for the first three months of 1956 topped the like period in 1955 by 64 per cent.

April 26

▲ The AISC reported March bookings of fabricated structural steel amount to 365,517 tons compared to 331,497 tons in February, 1956 and 285,434 tons in March, 1955. Shipments in March totaled 306,760 tons, leaving a backlog of work ahead as of March 31 of 2,463,432 tons.

▲ Westinghouse Electric Corp. sustained a loss of

$18,575,000 for the first quarter of 1956 compared with a net profit for the first quarter of 1955 of $12,782,000, or 75 cents per share. Sales for the respective periods amounted to $225,365,000 compared with $367,705,000 last year.

▲ February 1956 shipments of gray iron castings amounted to 1,215,000 short tons, 3 per cent below January, 1956 shipments of 1,250,000 tons, 10 per cent above February, 1955; malleable iron castings total of 94,000 tons approximately equaled January shipments, and a 9 per cent increase of February, 1955 shipments; steel castings shipments of 165,000 tons were 4 per cent above January shipments, and 55 per cent above February 1955 shipments reports the Bureau of Census.

▲ Ernest T. Weir, chairman of National Steel Corp., advocating a steel price increase stated that the first quarter's increased profits were not satisfactory in view of steel companies' need for higher revenue to finance expansion.

▲ The Commerce Department reported a record monthly figure with U. S. exports totaling $1,550,000,000 in March.

▲ Industry spokesmen for the tool and die makers predicted 1956 orders will reach above $800,000,000, compared with $700,000,000 last year and $750,000,000 in 1953 the previous volume record.

April 27

▲ C. L. Austin, president of Jones & Laughlin Steel Corp. addressing the annual meeting, advised that upon completion of the present construction program, the company will have many of the components necessary or desirable for the manufacture of stainless steel products, and is seriously studying an early entrance into this field.

▲ Aluminum, Ltd. announced plans to spend $250,000,000 for construction of a new hydro-electric project in northern Quebec, designed to support 150,000 tons of additional aluminum smelting capacity. This Quebec expansion and the construction in progress at Kitimat, British Columbia, will increase the company's aluminum capacity to over 1,000,000 tons by the end of 1959, compared with the 650,000 tons capacity at the end of 1955.

April 30

▲ The AISI reports that the operating rate of the steel industry for the week of April 30 is scheduled at 99.5 per cent of capacity. This is equivalent to 2,450,000 tons compared with 2,473,000 tons one week ago and 2,331,000 tons one year ago. Index of production for the week is 152.5.

▲ AISI reports estimated total employment in the iron and steel industry for March, 1956 at 685,200 compared with 629,200 in March, 1955, estimated total payroll during March is $338,140,000. Average hourly payroll cost of wage earners was $2.604 in March, compared with $2.385 during March, 1955, and average hr worked per week in March, 1956 was 40.7, compared with 41.1 in March, 1955.

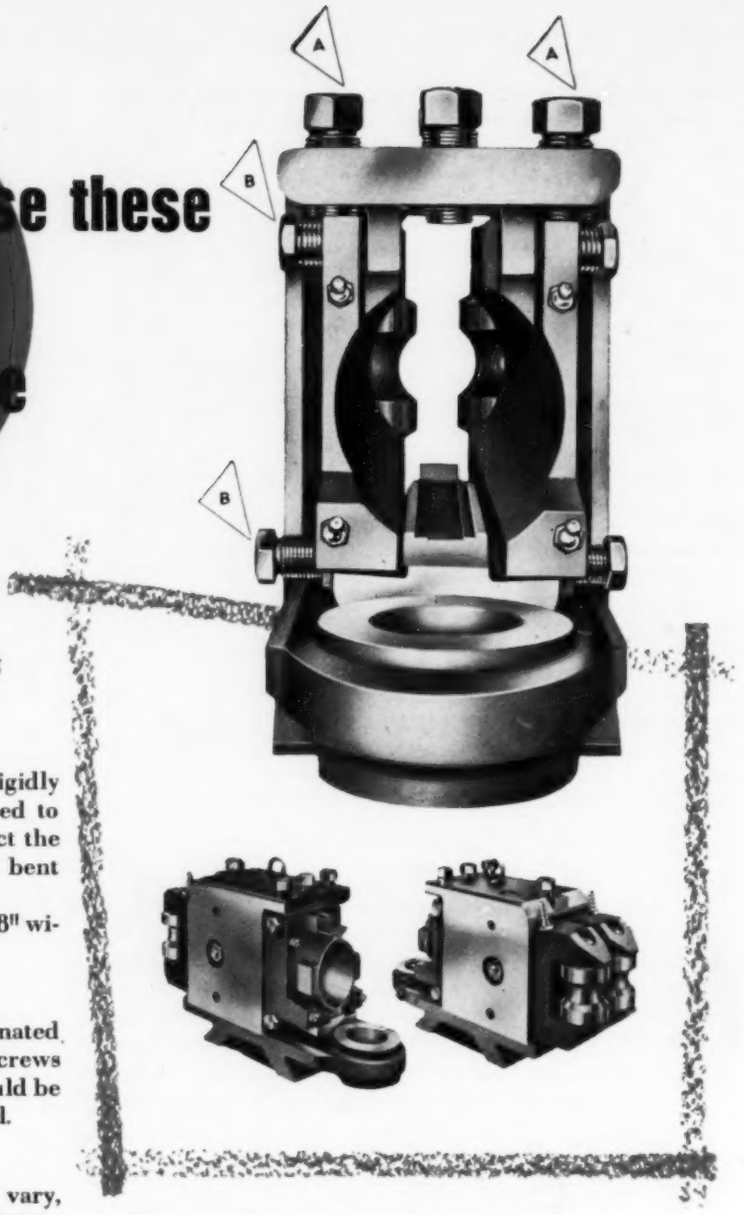
▲ A 3 per cent increase in prices was placed on some major pipe products due to increased costs of manufacture by U. S. Steel Corp.

▲ Steel producers set up a defense maneuver against a possible divide and conquer strike by the AFL-CIO United Steelworkers, and sent notifications to the Steelworkers that their labor agreement with the union would terminate on June 30. This procedure is in line with the Taft-Hartley Act provisions requiring 60 days notice. United Steelworkers had issued contract termination notices last week preparatory for this spring's negotiations

STEEL COMPANY QUARTERLY FINANCIAL REPORTS — JANUARY 1, 1956 TO MARCH 31, 1956

	1956 Net sales	1956 Net profit	1956 Earnings per share	1955 Net sales	1955 Net profit	1955 Earnings per share
Acme Steel Co.	$ 30,272,000	$ 1,863,144	$0.94	$ 24,780,000	$ 1,541,723	$0.78
Alan Wood Steel Co.	.....	689,172	.....	.....	269,397	.....
Allegheny Ludlum Steel Corp.	74,774,665	4,572,608	1.23	53,657,226	2,410,906	0.69
Armco Steel Corp.	189,958,346	19,678,979	1.81	154,773,640	12,689,123	1.21
Barium Steel Corp.	27,150,118	1,468,957	0.44	12,914,118	(471,594)	Loss
Bethlehem Steel Corp.	599,556,156	44,963,787	4.51	451,088,588	35,313,262	3.51
Carpenter Steel Co.	16,737,799	1,783,236	2.09	11,725,121	922,850	1.08
Colorado Fuel and Iron Corp.	.....	4,016,414	1.14	.....	2,929,894	1.04
Continental Steel Corp.	.....	728,643	.....	.....	699,805	.....
Copperweld Steel Co.	25,078,064	971,878	1.21	18,295,431	624,684	1.09
Crucible Steel Co.	69,250,787	3,680,966	2.04	50,943,010	2,248,896	1.25
Detroit Steel Corp.	.....	2,178,832	.....	.....	1,015,035	.....
Eastern Stainless Steel Corp.	12,107,400	913,189	1.57	8,073,841	521,555	0.90
Granite City Steel Co.	35,957,078	3,779,801	1.77	25,650,448	2,261,104	1.05
Inland Steel Co.	190,380,288	14,015,549	2.54	149,233,444	10,432,755	1.95
Interlake Iron Corp.	25,587,409	1,752,160	0.90	22,147,449	1,597,163	0.82
Jones & Laughlin Steel Corp.	195,272,000	13,559,000	2.09	151,962,000	9,642,000	1.50
Keystone Steel and Wire Co.	32,903,386	2,750,117	1.47	28,472,374	2,712,007	1.45
Lone Star Steel Co.	.....	2,243,866	.....	.....	809,405	.....
Lukens Steel Co.	.....	1,361,641	.....	.....	292,384	.....
McLouth Steel Corp.	.....	2,439,077	.....	.....	893,255	.....
National Steel Corp.	170,605,918	14,102,586	1.91	150,807,501	11,203,461	1.52
Pittsburgh Steel Corp.	49,944,000	2,469,624	1.46	37,195,787	909,741	0.40
Republic Steel Corp.	322,598,475	25,041,392	1.62	261,608,546	18,192,265	1.19
Rotary Electric Steel Co.	.....	613,220	.....	.....	825,459	.....
Sharon Steel Corp.	50,147,561	2,257,871	2.05	40,223,401	2,229,271	2.03
Superior Steel Corp.	8,225,615	192,639	0.57	9,216,229	415,833	1.19
United States Steel Corp.	1,100,543,080	104,160,945	1.83	873,327,061	72,652,402	1.25
Washington Steel Corp.	.....	447,999	.....	.....	469,430	.....
Wheeling Steel Corp.	67,855,000	5,280,000	2.53	53,883,452	2,892,273	1.28
Youngstown Sheet and Tube Co.	177,885,632	10,193,856	3.01	139,069,701	7,975,488	2.37

8 good reasons why you should use these ROLLER GUIDES in your bar or wire rod mill



The Morgårdshammar Roller Guides — patented in most countries of industrial importance — are constructed according to the following principles:

1 The entry friction guides are rigidly clamped into the guide box. They are intended to lead the oval to the groove in the roller, to protect the rollers against overloading, and to straighten bent rods.
The groove in the entry guides is made about 1/8" wider than the oval.

2 The rollers are mounted on laminated springs, which can be adjusted by means of the screws "B", and hold the oval steadily even if there should be some slight variation in the thickness of the oval.

3 If the thickness of the oval should vary, the springs of both rollers yield an equal amount, so that the oval remains in the centre of the groove.

4 To tilt the oval, the screws "A" are adjusted as shown by the arrows. One roller will then be lifted as much as the other is lowered.

5 As the oval is held very rigidly, the leader oval for wire rod may be plump, unless other circumstances call for a thinner oval.

6 The roller guide assemblies are narrow, and all screws that require adjustment during rolling are accessible from the front of the mill. No lateral space outside the guide box is therefore required for gaining access to the set screws, and the guide box assembly can thus be located close to the mill housing.

7 As the groove in the entry guides is wide and nothing but rolling friction acts on the oval, the latter is very easily introduced into the pass, and there is practically no risk of scratching the bar.

8 The roller guide may be used not only for leader and break-down oval passes but also for edging flats as well as for rolling squares, hexagons, octagons and various other sections, for instance in reduction passes for hexagon. It is suitable for all types of rolling mills. An important advantage is that the roller guide enables repeaters to be used in rolling plump leader-ovals.

P.S. *Practically speaking, every bar and wire rod mill in Scandinavia uses roller guides of our design.*

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Or he may be cleaning it *before* repairs, so that the mechanic who tears it down and works on it won't need to waste 40% of his time wiping and scraping greasy muck. But whatever his purpose, you may be sure he's saving his company money, for JENNY is one of the greatest time, labor and money saving shop tools any plant can own.

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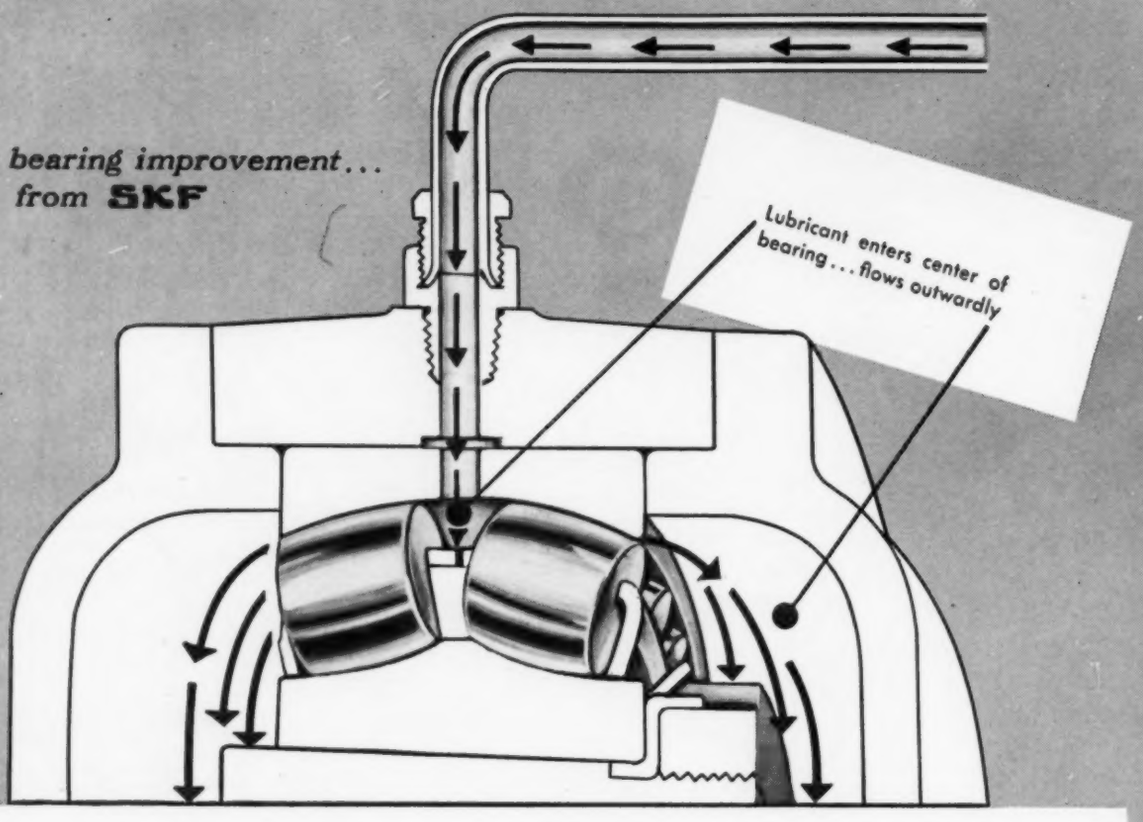
Another bearing improvement... from **SKF**



NOW AT NO EXTRA CHARGE-

SKF's improved method of lubricating large spherical roller bearings

To make the lubricant effective it should be located where needed—in the bearing. Also, new lubricant, when added, should enter where it does the most good—in the bearing.

For these reasons, all future production of SKF double row spherical roller bearings above 240 mm O.D. (9.4488") will be made with three equally spaced drilled holes in the center of the outer ring without any extra charge to our customers. *This permits the lubricant to enter the center of the bearing.*

With the lubricant (either grease or oil) being introduced into the center of the bearing, all working surfaces are quickly and completely covered. In addition, the outward flow flushes out the old lubricant, and with it, any abrasive dust, dirt, moisture or other impurities.

And where circulating oil lubrication is required, there is a continuous flushing and cooling of the bearing.

This is another example of how SKF helps you to obtain longer bearing life.

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Consult your SKF District Office today for complete information so that you can be the first to incorporate into your products this improved method of lubricating large spherical roller bearings.

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FAIRMOUNT GLASS WORKS, INC.,
INDIANAPOLIS, IND.

"We make combustion adjustments in minutes with the Cities Service Heat Prover!"

700 employees . . . 27 acres of plant facilities . . . and a yearly production of 288,000,000 bottles—that's Fairmount Glass Works at Indianapolis, Indiana, a beehive of activity where delays can't be tolerated.

So, when furnace combustion adjustments consistently caused as much as a day's delay and gave poor accuracy, Fairmount had to find something better fast! And they did . . . in the form of the Cities Service Heat Prover. This unique, portable testing instrument makes simultaneous readings of oxygen and combustibles, keeping a constant check on combustion conditions.

Thus, Fairmount's operators are now able to adjust the amount of combustion air to the amount and kind of gas being used . . . and they do it, port by port, in minutes!

In addition, the Heat Prover has proved virtually indispensable in shifting furnaces from producer gas to gas made outside the firm. Says Plant Superintendent Cedric C. Rau, **"It's one of the most useful, versatile, and accurate instruments we've ever seen."**

The Heat Prover is supplied and maintained free by Cities Service. For further information regarding its availability and uses, write: Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.

Checking Combustion in Glass-Melting Furnace, a Fairmount employee uses the Cities Service Heat Prover for faster, more accurate adjustments. The instrument is supplied free by Cities Service.

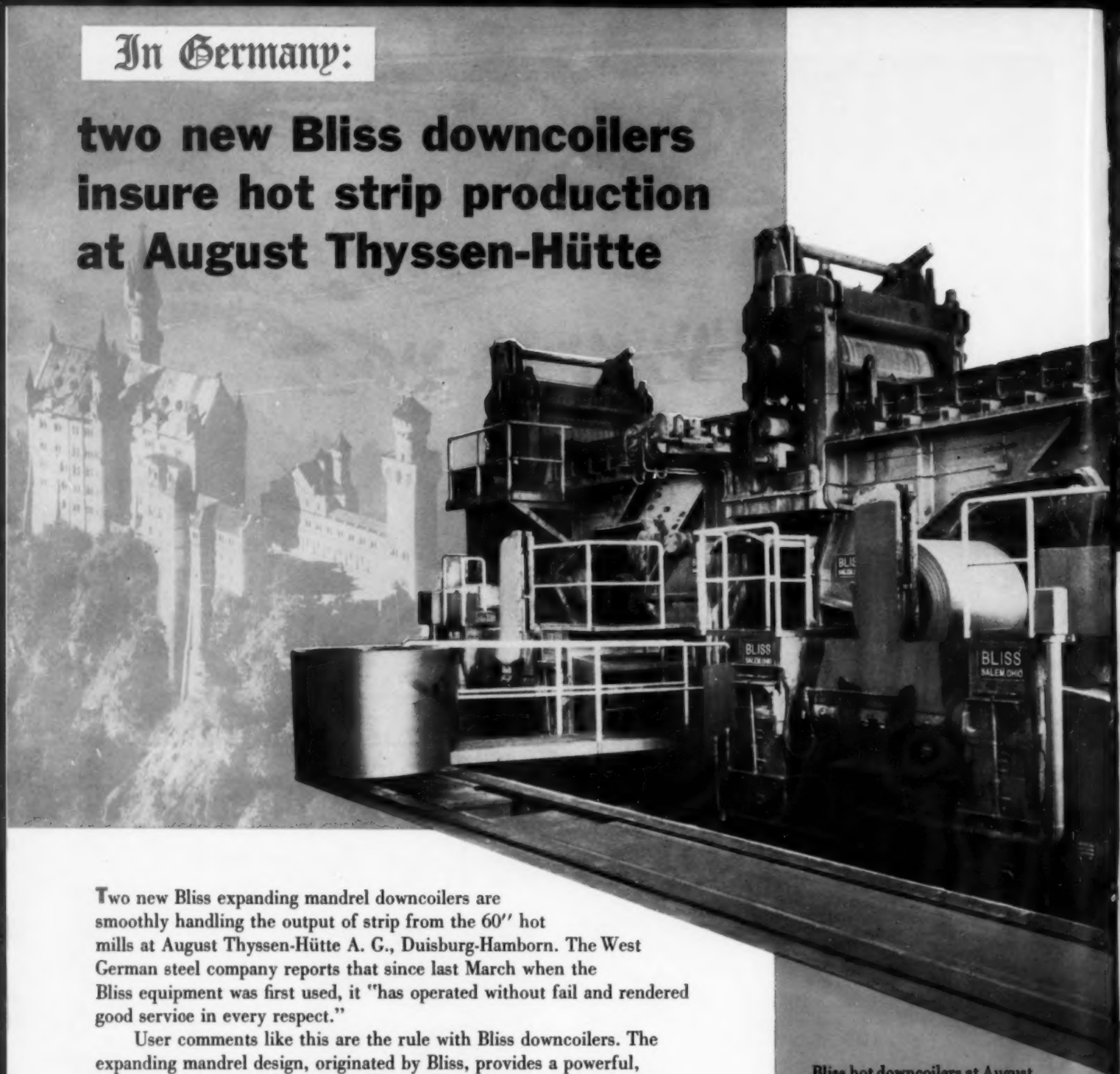
Production's Never Bottled Up at Fairmount Glass Works. They produce 288,000,000 bottles a year, use 225,250 tons of glass daily, with many machines turning out 100 bottles a minute!

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

In Germany:

two new Bliss downcoilers insure hot strip production at August Thyssen-Hütte



Two new Bliss expanding mandrel downcoilers are smoothly handling the output of strip from the 60″ hot mills at August Thyssen-Hütte A. G., Duisburg-Hamborn. The West German steel company reports that since last March when the Bliss equipment was first used, it "has operated without fail and rendered good service in every respect."

User comments like this are the rule with Bliss downcoilers. The expanding mandrel design, originated by Bliss, provides a powerful, smooth-as-silk coiling action that winds tight coils with even edges. The blocker rolls touch the strip only when the initial wraps are made and the ends are being taken up. Thus, there is no scratching or surface damage during coiling.

You'll find Bliss equipment . . . and satisfied users . . . in rolling mills all over the world. To acquaint yourself with our products, why not write today for a copy of our 60-page Rolling Mill Brochure, Catalog 40-A? It's yours for the asking.

Bliss hot downcoilers at August Thyssen-Hütte coil strip in widths from 24″ to 60″. Mandrel diameter is 28″, and maximum coil O.D. is 56″. The two upenders were also designed and built by Bliss.

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General Office: Canton, Ohio
ROLLING MILL DIVISION: SALEM, OHIO

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And General Refractories, to provide the complete refractory service that industry needs, employs the world's largest, most-modern refractories research laboratory and 66 mines and manufacturing plants both here and abroad.

A Complete Refractories Service

GENERAL REFRACTORIES COMPANY

Philadelphia 2

A COMPLETE REFRACTORIES SERVICE FOR THE STEEL INDUSTRY

OLIVE HILL BF and OLIVE HILL HI-FIRED brick rank high in any list of prominent and widely used brands of blast furnace refractories. Manufactured from dense-burning Kentucky flint fire clays by Grefco's unique manufacturing processes, OLIVE HILL brick set a standard for blast furnace refractory quality and workmanship.

Grefco processing of OLIVE HILL brick entails:

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2. Grinding and screening to prescribed formula to promote high density of product.
3. Efficient dearing during brick forming, also to promote density and proper physical structure.
4. Careful firing to exacting temperature schedules to yield uniform high quality brick.
5. Close inspection of final product with gauging and sorting of brick to close size tolerance.
6. Quality control by statistical analysis procedures for the manufacturing processes.

In service, OLIVE HILL blast furnace brick, both BF and HI-FIRED, have produced many splendid performance records in the past. OLIVE HILL linings in presently operating furnaces, are giving outstanding performance and are more than meeting the increasing requirements of the expanding American Iron and Steel Industry.

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LIMA, OHIO

Plants at Lima and Springfield, Ohio

OR4

Industry News...

NATIONAL TUBE DIVISION WILL CONSTRUCT NEW COKE OVEN BATTERY AT LORAIN WORKS

▲ Construction of a new battery of 59 by-product coke ovens has been scheduled for the Lorain Works, National Tube Division, U. S. Steel Corp., according to an announcement made by L. F. Sattele, assistant general superintendent at Lorain.

When completed, the new battery will be the seventh addition to the coke plant since extensive modernization efforts began in 1946. Designated as Battery D, the new unit will carbonize approximately 1100 tons of coal a day and will also eventually boost the plant's production of coal chemicals.

Included in the construction will be additional auxiliary equipment for coal handling and chemical recovery. Like the other six batteries, the new unit will incorporate the latest features for smoke reduction and control. The battery will require about a year to build.

Battery D will replace an older coke oven battery which operated continuously at the Lorain plant since 1918.

REPUBLIC TO EXPAND METAL LATH CAPACITY

▲ A modernization program which will double the metal lath producing capacity at the Truscon Steel Division of Republic Steel Corp. in Youngstown, Ohio, was announced by D. K. Forsyth, division manager.

The program, already underway, is expected to be completed about the middle of next year without interfering with present production schedules.

Included in the program will be a change in the manufacture of metal lath and accessory products. The products will be made from coil stock instead of from sheets, the present method. This change is expected to improve finished quality of the product and reduce manufacturing cost.

New equipment to be added includes a 3/8-in. rib lath which will decrease the size of openings between ribs while increasing the width of sheets from the present 24 in. to 27 in.

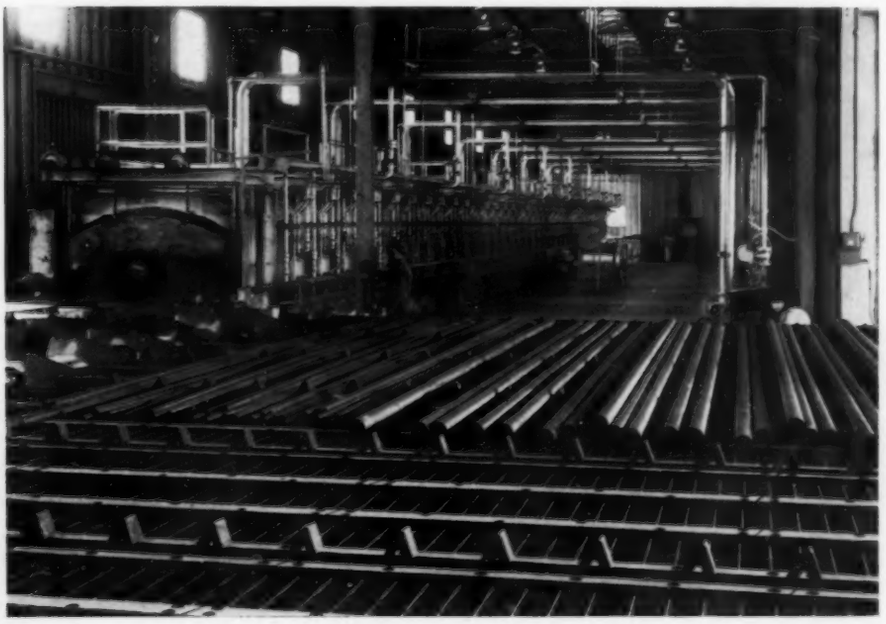
A complete small mesh diamond lath setup is expected to be put in operation by the end of this year with the possibility of a duplicate unit being installed later.

VACUUM CHAMBER

Workmen make test assembly of America's first airtight chamber for vacuum casting of large forging ingots. The unit will go into operation soon at U. S. Steel's Duquesne Works. Fabricated and designed by American Bridge, the chamber is 17 ft in diameter and 31 ft high, including the base and top sections.

NEW FURNACE GOES INTO OPERATION AT TIMKEN

A new $245,000 roller hearth furnace and building have been erected at Timken Roller Bearing Co.'s Gambrinus steel mill. Housed in a pre-fabricated galvanized building, the new furnace measures 150 ft 6 in. in length, 6 ft wide, and 3 ft high, and can handle up to 4000 tons of steel per month. The new furnace is charged and discharged by means of a big fork lift truck. The roadways at the charging and discharging ends of the furnace, as well as the roadway along the side of the furnace building, are radiantly heated to eliminate snow and ice hazards during the winter months.



AWARDS PLATE MILL CONTRACT TO MESTA

▲ A contract covering the design and manufacture of a 160-in. reversing plate mill at the Sparrows Point, Md., plant of Bethlehem Steel Co. has been awarded to Mesta Machine Co.

The contract includes two new automatically controlled slab reheating furnaces with charging and delivery equipment, a 38 in. & 59 in. x 160 in. four-high reversing plate mill, a vertical edging mill, leveller, shears, trimmers, cooling bed, scales, tables, transfers, and plate handling cranes. An existing three-high mill will be arranged to serve as a roughing stand

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COUPLINGS

The motor driven boiler feed pump application pictured above needs a WALDRON coupling to make it a top engineering and mechanically perfect installation. That's why WALDRON is being specified by more and more pump and compressor manufacturers.

SHEAR PIN ... CUT-OUT ... FLOATING SHAFT ... SPACER ... OIL COLLECTOR
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Complete details in Catalog 57

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Sales Representatives in Principal Cities
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in the new installation. The plate mill and edging mill are driven by a total of 11,250 hp.

Mesta will be responsible for the complete layout, will make all the engineering details required for the construction of foundations and electrical systems and will supervise the work of installation in the field.

INDIANA SMELTING PLANT TO BE BUILT BY ALCOA

▲ Aluminum Co. of America announced that it will construct a 150,000-ton smelting plant near Evansville, Ind.

John D. Harper, general manager of Alcoa's smelting division, said the smelter and a 375,000 kilowatt steam power plant, fired by coal, will be built about 18 miles east of Evansville in Warrick County, on the Ind. side of the Ohio River. Cost of the project will be approximately $80,000,000.

Named to manage the company's newest smelter was John R. Ibach, a veteran of more than 31 years with Alcoa, and recently electrical superintendent of the company's operations at Massena, N. Y.

First production from the new plant is scheduled for the fall of 1957. Fully integrated operation of the smelter on its own power is expected by mid-1958, Mr. Harper stated.

The smelter will increase Alcoa's installed primary capacity, existing and planned, to 942,500 tons. At the end of 1955 the company was producing at an annual rate of about 700,000 tons. A current 86,000 ton expansion of smelting capacity is being carried out at Alcoa's Texas and Wash. plants.

RYERSON BUYS PROPERTY FOR NEW SERVICE PLANT

▲ Purchase of property in Indianapolis, Ind., as the site for a new steel service plant was announced by Joseph T. Ryerson & Son, Inc.

Charles L. Hardy, Ryerson president said the company has entered into an agreement to purchase a 14-acre tract of land from the Pennsylvania Railroad. The new plant, to cost approximately $1,000,000 for building and equipment, is planned to be in operation early in 1957.

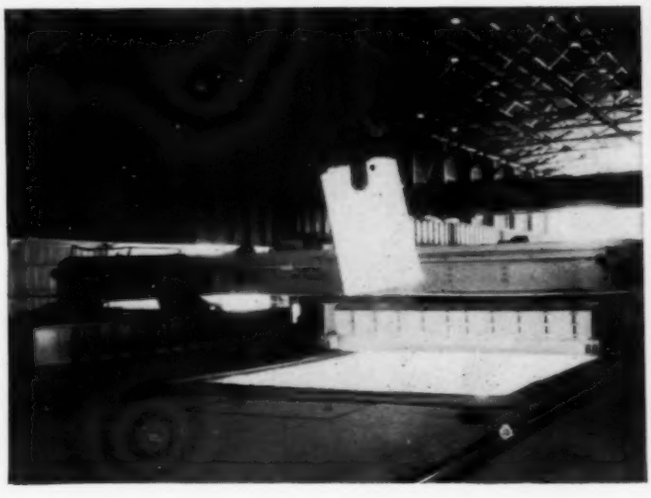
The new plant will have adequate

(*Please turn to page 178*)

Open Hearth Furnaces—Photo Courtesy
Jones & Laughlin Steel Corp.

Continuous Heating Furnaces—
Photo Courtesy Crucible Steel Co.

Soaking Pit—Photo Courtesy
United States Steel Corp.



Heat Treating Furnace—
Photo Courtesy Taylor Forge & Pipe Works

Increase Production . . . Lower Production Costs with

LOFTUS Industrial FURNACES

For years Loftus Industrial Furnaces have been providing dependable, economical service to the steel industry. Their long life and efficient performance have been proved by time. The fact that they materially contribute to lower-cost operation and increased production is a matter of record.

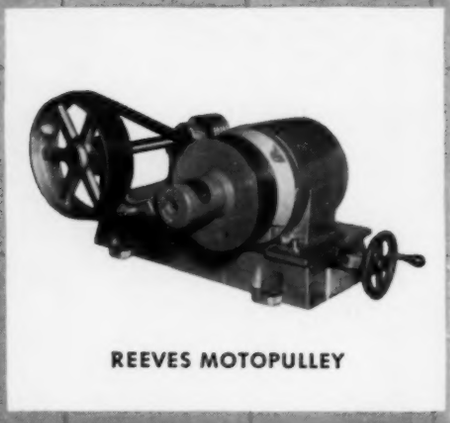
Whatever your heating or heat-treating requirements, it will pay you to take advantage of Loftus' long experience in furnace design and construction. Many of the world's leading companies have—and to their utmost satisfaction, as proved by the high percentage of repeat orders we get.

We would welcome an opportunity to quote on your requirements.

Designers and builders of industrial furnaces

LOFTUS
Engineering Corporation

610 Smithfield Street, Pittsburgh 22, Pa.



• WIDENING THE HORIZONS OF

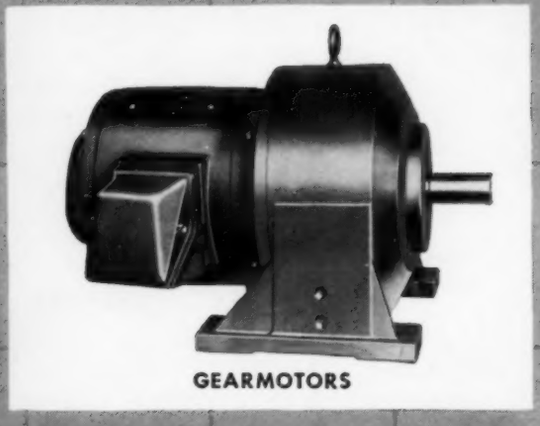
Automation is the key to greater production of more goods and services at lower cost. The Tools of Automation can be applied profitably in a countless number of individual industries.

Reliance can provide *you* with valuable engineering assistance which can help secure the advantages of automation.

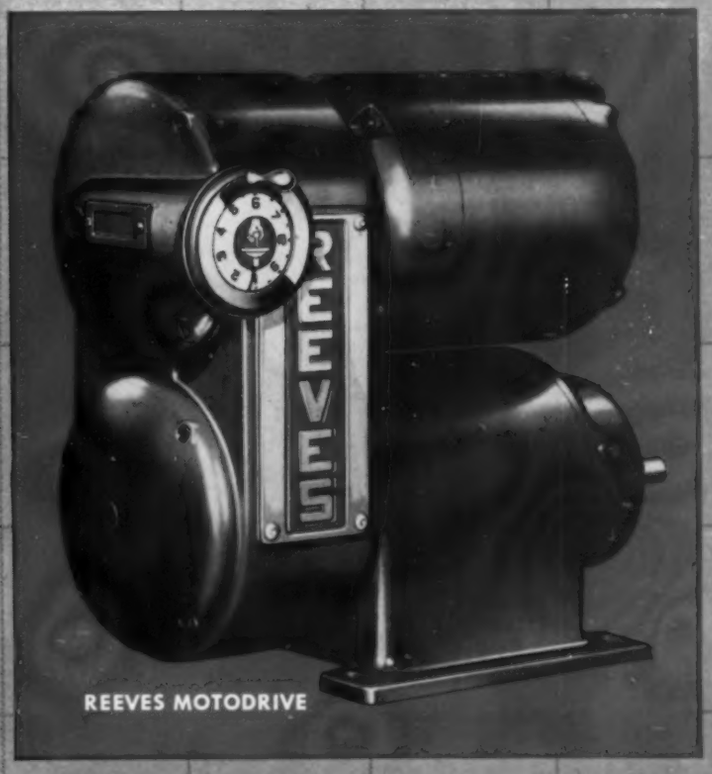
Our Tools of Automation consist of electric motors, variable-speed drives and controls.

RELIANCE

TOTALLY-PROTECTED MOTORS



GEARMOTORS



REEVES MOTODRIVE

RELIANCE MOTORS ON HIGH SPEED AUTOMATIC TRANSFER MACHINES

AUTOMATION

Application of these tools ranges from a single motor to multi-motor drives for highly complex production lines, where materials are processed into finished products in one continuous operation.

The world's largest manufacturer devoted exclusively to the production of quality motors and drives is ready to help you widen the horizons of automation in your plant.

Bulletin No. A-1555-B gives further details.

A-1519

ELECTRIC AND ENGINEERING CO.

DEPT. 115A, CLEVELAND 10, OHIO

Canadian Division: Welland, Ontario • Reeves Division: Columbus, Indiana

Sales Offices and Distributors in Principal Cities

SELECT

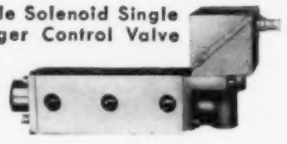
Quick-As-Wink®

AIR AND HYDRAULIC

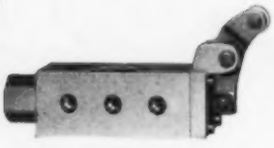
CONTROL VALVES

DESIGNED AND BUILT TO ASSURE

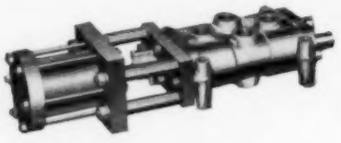
Double Solenoid "O-Type" Control Valve



Single Solenoid Single Plunger Control Valve



Cam Operated "O-Type" Valve



Pilot Cylinder Operated Two Position Hydraulic Valve

efficient and dependable operation of your machines and machinery

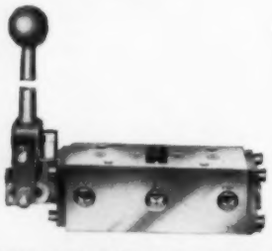
Can you afford to gamble with less?

• Why build — or buy — expensive machines and then restrict their output and risk breakdowns and production tie-ups because of inferior control valves?

Positive and fast acting Quick-As-Wink valves meet the most exacting requirements. They deliver dependable precision performance month after month and year after year. Machine operators, foremen, superintendents *and machine builder trouble shooters* will tell you that there is nothing better than a Quick-As-Wink valve. REMEMBER,— your efforts to increase production and cut costs can only be as successful as the air and hydraulic valves that control the operations. Don't gamble. Play safe. Specify Quick-As-Wink valves. Get full details. Write for Bulletin No. 531, *Today!*

Ask us also about . . .

FOOT OPERATED SLIDING SLEEVE VALVE ⅜" to 1" sizes. Single pedal spring return and two pedal designs. Operator has both hands free to handle the work.



LEVER OPERATED SINGLE PLUNGER VALVE ⅜" to 1½" sizes. Widely used for controlling single and double acting cylinders and as pilots for other valves.

Quick-As-Wink®

AIR AND HYDRAULIC

Control Valves

Hand, Foot, Cam, Pilot, Diaphragm and Solenoid Operated

Mfd. by C. B. HUNT & SON, INC., 1929 East Pershing St., Salem, Ohio

(*Continued from page 174*)

floor space for stocking steel bars, plates, sheets, structural shapes and tubing. The stocks will include carbon, alloy and stainless steels.

Equipment for sawing, shearing, and flame cutting steel to customers' requirements will be installed. Modern office quarters will be provided for sales, service and operating departments.

TO FURNISH ANNEALING UNITS FOR WHEELING

▲ Wheeling Steel Corp. has contracted with Lee Wilson Engineering Co., Inc. to design and furnish a $700,000 single stack annealing furnace installation at the Yorkville, Ohio mill.

The installation, part of a general expansion at Yorkville, includes the engineering and construction of 17 single stack furnaces and 50 bases. These furnaces will be used exclusively for the production of tin plate coils, and are designed for a 72 in. diameter maximum size coil and a piling height of 156 in.

AWARDED CONTRACT FOR J&L CONVERTERS

▲ Pennsylvania Engineering Corp. has been awarded a contract by Kaiser Engineers to fabricate the two largest oxygen converters in the world. Two top blown oxygen steel converters of 65-ton capacity will be fabricated for installation at the Aliquippa Works of Jones & Laughlin Steel Corp.

The J & L converters will be the second installation of the oxygen converter process for steelmaking in the United States. The first installation was made at McLouth Steel Corp. using two 35-ton vessels.

U. S. STEEL BUILDS NEW SINTERING PLANT

▲ Construction has begun on a new sintering plant at Houseville, Pa., it was announced by Harvey B. Jordan, executive vice president—operations of United States Steel Corp.

Composed of three modern sintering units, the new plant will be capable of processing about 15,000 tons of domestic and foreign ores daily for the corporation's plants at Duquesne, Clairton, Homestead and Braddock, Pa.

NEW!

BUFFALO "BLH"
FOR CLASS II THRU IV
VENTILATING-INDUSTRIAL & MECHANICAL DRAFT SERVICE

THE NEW "Buffalo" Type "BLH" FAN is engineered for installations where total pressure requirements of 3¾" and up exist. These applications include mechanical draft, conduit air conditioning and many industrial applications.

CANTILEVERED INLET VANES eliminate center ring, reducing turbulence and improving air flow through the inlet. The die-formed inlet vanes and inlet bell further contribute to smooth air flow, minimizing effects of unfavorable inlet conditions.

THE PROVEN BL WHEEL has a deep drawn flange to form a true half-circle with the inlet cone. Highly efficient non-overloading backward-curved blades, solid back plate and extra heavy hub make this wheel ideally suited to this service.

IMPROVED FAN OUTLET — reduces outlet air turbulence from fan cutoff into duct by making more even, gradual change from velocity to static pressure. Without this complete streamlining of inlet, housing AND outlet, such high efficiency is impossible.

Smooth Divergent Flow

86% MECHANICAL EFFICIENCY — made possible by a combination of inlet, wheel and housing design. The smoothest "air-ride" in fan history.

"Buffalo" "Q" FACTOR* CONSTRUCTION gives you many years of trouble-free service. Housing is all-welded construction. Wheel and blades are riveted and welded for maximum strength, the basic design having been thoroughly tested in the Vacuum Pit, a "Buffalo" exclusive.

AVAILABLE in wheel diameters from 18¼" to 80¾", the new "Buffalo" "BLH" merits your consideration. Write for details on your company letterhead — today.

**The "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.*

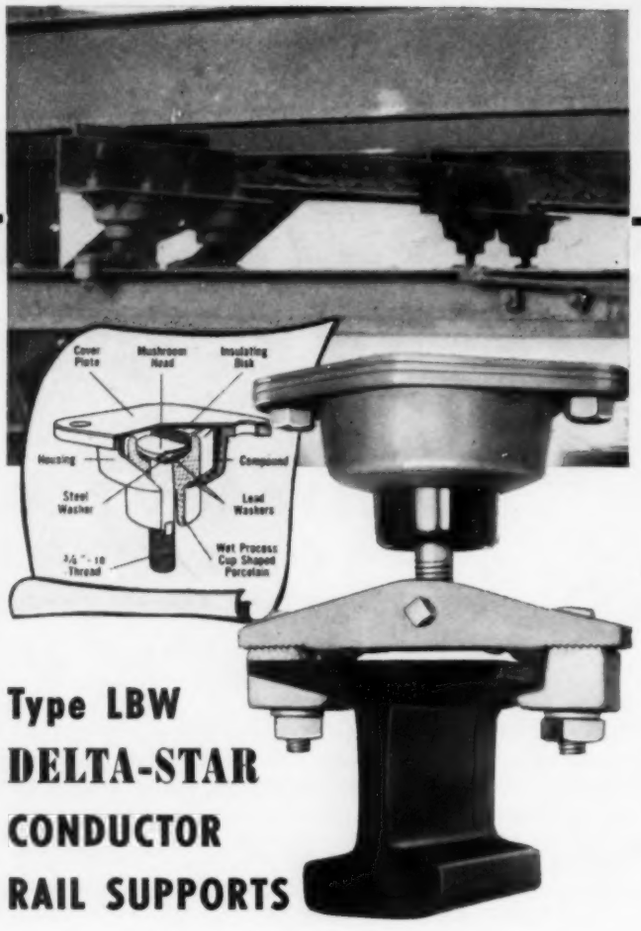
BUFFALO FORGE COMPANY

BUFFALO, NEW YORK

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

"Buffalo"

VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING FORCED DRAFT COOLING HEATING PRESSURE BLOWING



Type LBW DELTA-STAR CONDUCTOR RAIL SUPPORTS

for absolute safety, long-life dependability

These DELTA-STAR Type LBW conductor rail supports for under-hung conductor rails assure positive support, maximum shock resistance, safe load carrying strength and long service life.

The mushroom head bolt design, with porcelain insulators under compression, gives the support *greatest possible strength*. This also makes it impossible for rails to drop even if the porcelain insulator is accidentally broken. Notched base clamps and grips plus ½-inch adjustment of supporting bolt provide *liberal adjustment* for various rail sizes and for slight misalignment. The inverted design prevents collection of dirt, sleet and ice on the rail contact surface.

DELTA-STAR offers supports for over-running rails, as well as under-hung rails, and special supports for use with angles, T-bars or flat bars. Write for DELTA-STAR Conductor Rail Support Bulletin 5005 for complete data—or see your DELTA-STAR representative.

HKP DELTA-STAR ELECTRIC DIVISION
H. K. PORTER COMPANY, INC.
2437 Fulton Street · Chicago 12, Illinois · District offices in principal cities

The Houseville site was selected because of its central location, permitting easiest assembly of ores from both the Mesabi district and from foreign sources. It will be constructed on a several hundred acre tract of land.

Each new unit will consist of four essential parts: a continuous traveling grate to carry the materials; a furnace to fire the fuel contained in the mixture; a series of wind boxes to accelerate the fusing of the particles of iron being processed; and numerous dust collectors that will prevent dust from emanating into the air during the operation.

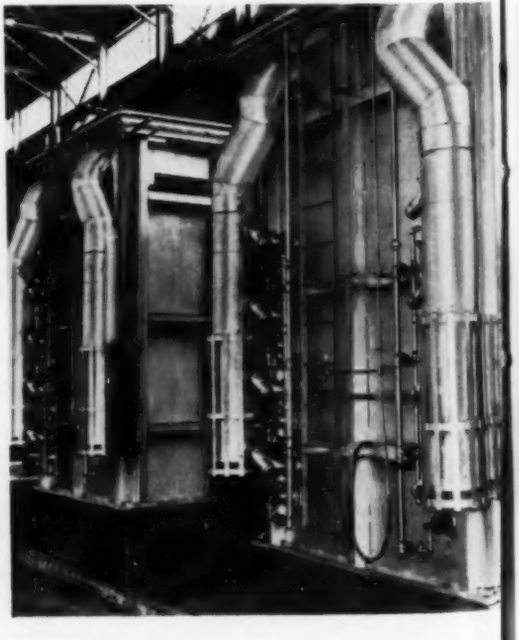
Dravo Corp. has been awarded the contract for design and construction of the plant, which is scheduled to be completed in early 1957.

NEW COMPANY TO BUILD SCHACK RECUPERATORS

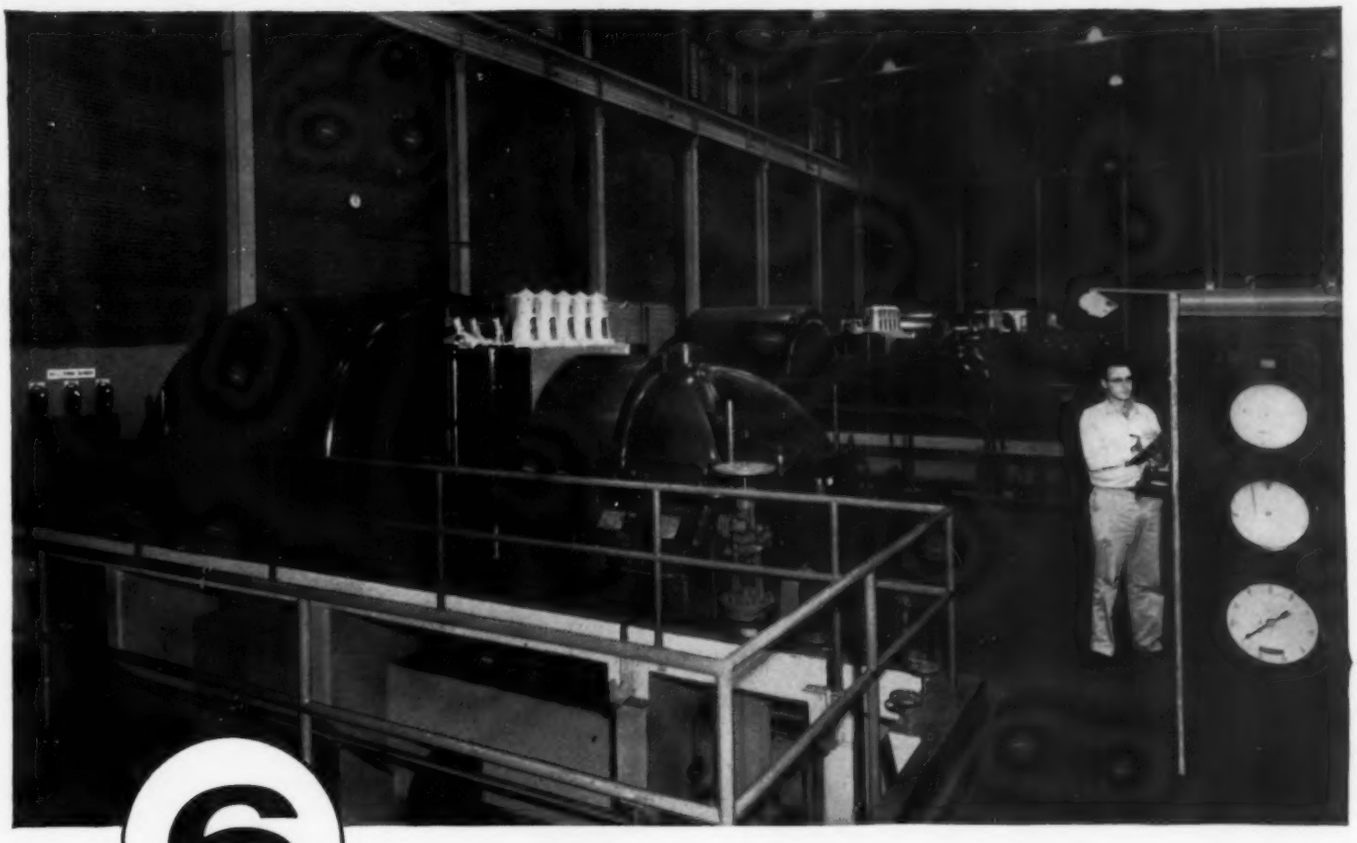
▲ Formation of the Griscom-Russell-Schack Co., Inc., was announced jointly by Mr. K. B. Ris, president of the Griscom-Russell Co., a subsidiary of Genral Precision Equipment Co., and Dr. A. Schack, president of the Schack Rekuperator Co., Dusseldorf, Germany. The new com-

ANNEALING UNIT

Loftus Engineering Corp. has recently finished installation of ten cover type annealing furnaces with twenty-seven bases at the Vandergrift Works of U. S. Steel Corp. These furnaces comprise an important portion of the new equipment being installed at this mill in line with the corporation's increased activity in the silicon steel field.



at U.S. STEEL's Columbia-Geneva Steel Division



6 I-R TURBO-BLOWERS supply BLAST FURNACE WIND

The photo above shows the blowing room at the Geneva Works of U.S. Steel's Columbia-Geneva Steel Division in Utah. Here, four Ingersoll-Rand Turbo-Blowers, each rated 95,000 cfm, 35 psig, supply wind for the blast furnaces at this large, modern steel mill. These four identical blowers, installed in 1943, are driven by I-R steam turbines, each served by an I-R surface condenser.

A thoroughly dependable air supply is of vital importance to assure continuous operation of the blast furnaces. The performance of these units, over the past 12 years, has therefore contributed materially to uninterrupted production at this important western plant.

For year - after - year dependability, it pays to specify Ingersoll-Rand Turbo-Blowers and accessory equipment.

32 YEARS' SERVICE AT IRONTON WORKS

Here, a few miles from the Geneva Works, are two more I-R Turbo-Blowers that are still in successful operation after 32 years of service. Installed in 1923, they were originally rated 42,000 cfm at 25 psig, but the interiors were later rebuilt to increase the rating to 46,000 cfm at 28 psig. Both units are driven by I-R steam turbines, served by a common I-R barometric condenser.

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y.

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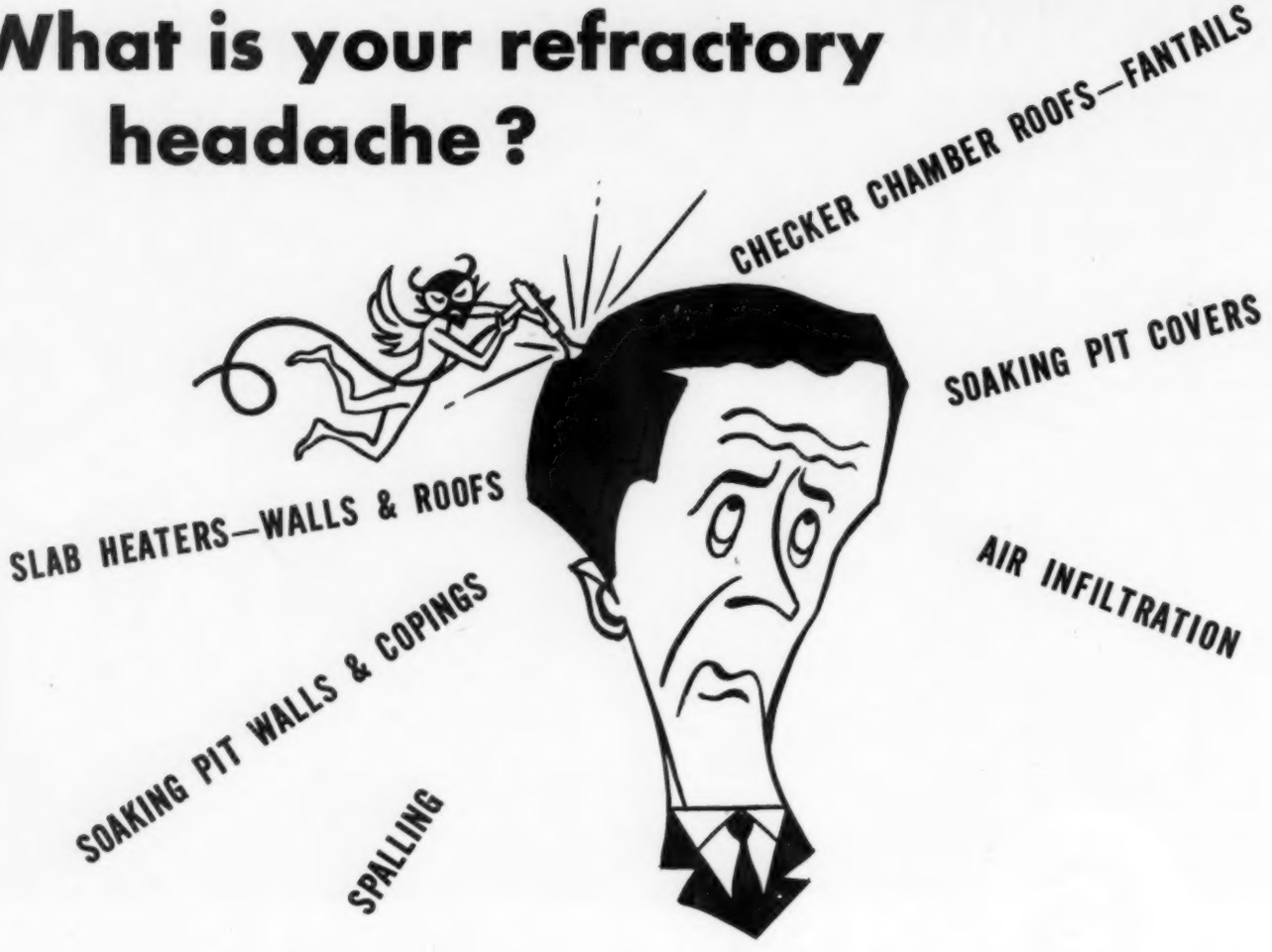
COMPRESSORS • AIR TOOLS • OIL AND GAS ENGINES • CONDENSERS • CENTRIFUGAL PUMPS

What is your refractory headache?



Try Ramtite—the aspirin refractory

RAMTITE is not a cure-all for refractory headaches. However, we have cured many of them during the past 30 years (the last 10 years in the steel mills), and maybe we can help yours.

RAMTITE service salesmen and engineers will thoroughly examine your refractory headache, accurately diagnose it, and prescribe treatment to your mason superintendent for a complete and speedy recovery.

RAMTITE is a monolithic plastic refractory — air tight, flame tight, and gas tight. Made from highest quality materials and installed under RAMTITE COMPANY expert supervision.

THE Ramtite CO.

Div. of The S. Obermayer Co.

RAMTITE IS OUR BUSINESS — NOT A SIDELINE

THE RAMTITE CO., Div. of The S. Obermayer Co.
1813 South Rockwell St., Chicago 8, Ill.

Please send items checked

☐ Bulletin on Castable and Gunning Refractories
☐ Steel Plant Bulletin

Company Name .....

Attn. Mr. ..... Title .....

Address .....

City ..... Zone .... State .....

pany will manufacture and market Schack recuperators.

Headquarters and main sales offices of the new firm are located in Pittsburgh under the direction of T. E. Dixon, vice president in charge of sales, and Heinz Kuhne, vice president in charge of design and engineering. Fabrication of the recuperators will take place in the Griscom-Russell plant in Massillon, Ohio.

The Schack recuperator transfers what normally is waste flue heat, entrained in spent gases emitted by furnaces and soaking pits, to incoming combustion air. The recuperator can be used for air preheats up to 1400 F. These levels, previously unattainable with metallic units are made possible by the patented design and application of high alloy steels.

ALLOY STEELS NAMED TIMKEN DISTRIBUTOR

▲ The Timken Roller Bearing Co. announced the appointment of Alloy Steels, Inc., Detroit, Mich., as its distributor for Timken Graphitic tool steels, bars, billets and hollow shapes. Thomas Phillips, president of Alloy Steels, Inc., indicated that a complete line of Timken tool steels would be handled.

A. Milne and Co., distributor of Timken tool steels in the East, the Midwest, and the West Coast, will also handle them in Detroit.

Peninsular Steel Co. of Detroit, distributors of Timken Graphitic Steels for a number of years, will continue in this capacity in Detroit and other cities where they maintain warehouses.

REPUBLIC PLANT TO GET NEW ANNEALING FURNACE

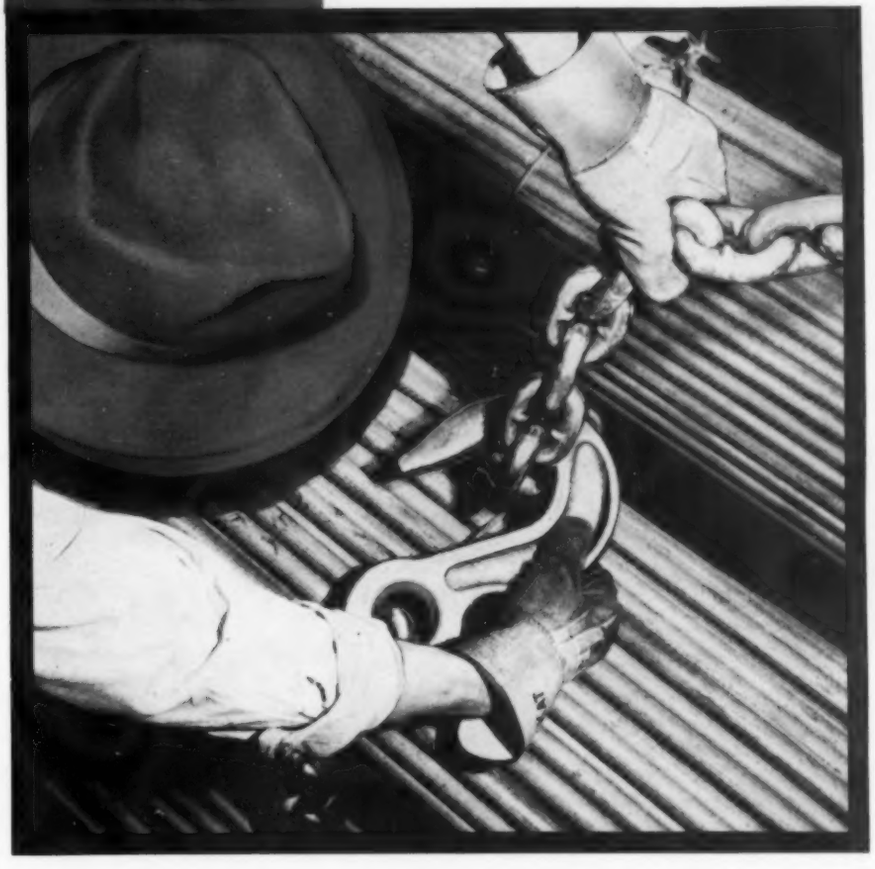
▲ A continuous carbon correction annealing furnace will be installed at Republic Steel Corp.'s Union Drawn Steel Division plant at Massillon, Ohio.

This is the third furnace of its type, designed by the division's chief metallurgist, J. D. Armour, to be installed by Union Drawn. The first one was put into operation at Massillon in 1951. Another was installed at Union Drawn's Gary, Ind., plant in 1954.

The new continuous furnace will have a capacity of approximately 1000 tons a month. It is expected to be in operation early in 1957.

Revolutionary

NEW HOOK DESIGN



...assures maximum safety and strength under the most severe conditions!

Avoid smashed fingers, broken hands and other serious and costly accidents with Taylor Chain's new Alloy Steel Tayco Hooks. Patented I-Beam type design provides a safe gripping channel for the hooker's hand... increases the strength and life of the hook immeasurably.

Large area above the eye further increases the hook's life. Oversized eye reduces joiner link wear. Drop-forged from Alloy Steel and heat-treated—Tayco Hooks have great resistance to shock, grain-growth and work-hardness at all temperatures. Available separately and as standard equipment on all Taylor Made Alloy Sling Chains.

SEE YOUR DISTRIBUTOR, OR SEND COUPON TODAY!

S. G. Taylor Chain Co., Hammond, Ind.; Pittsburgh, Pa.

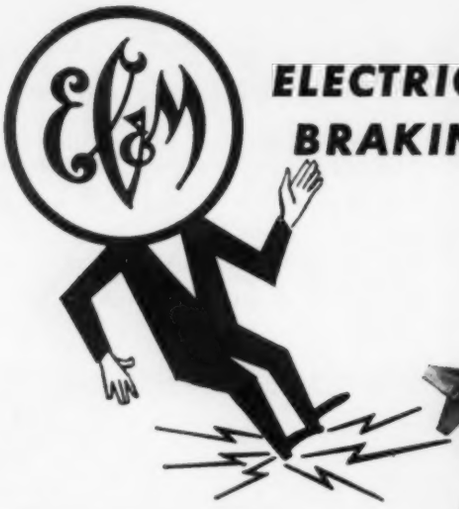
TAYLOR MADE
A GREAT NAME IN
Chain SINCE 1873

S. G. Taylor Chain Co.
Dept. H, Hammond, Indiana
Please rush Bulletin No. 90 giving all the facts and specifications on Tayco Hooks.

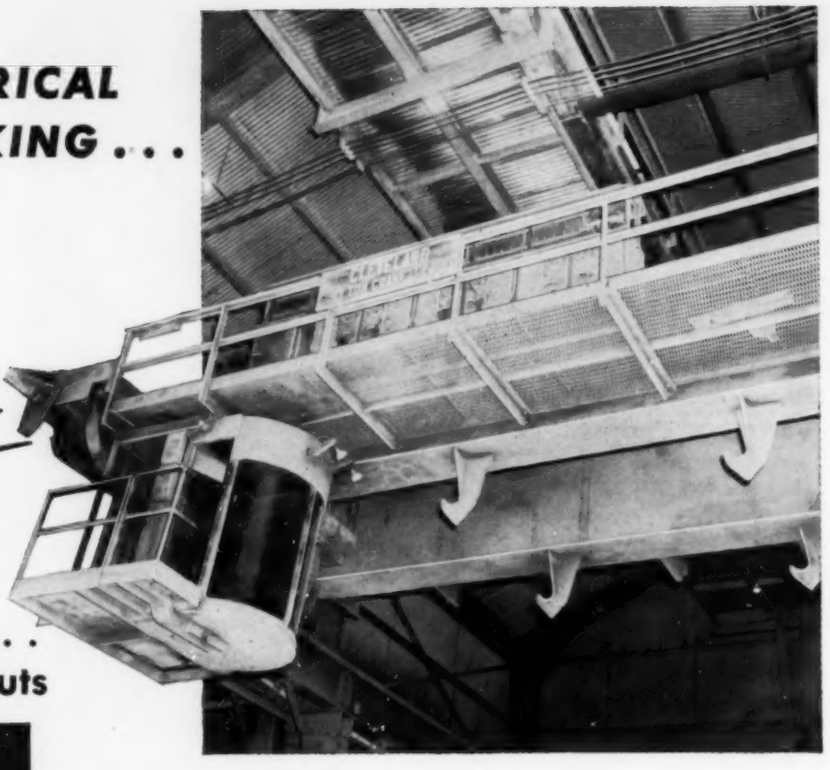
Name_____

Address_____

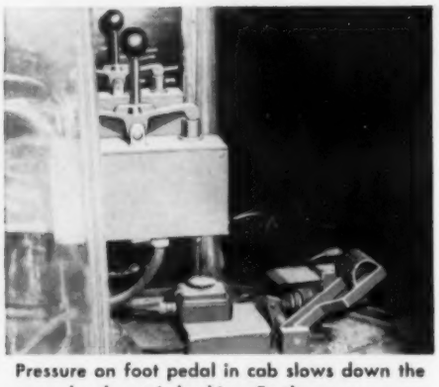
City_____ State_____



ELECTRICAL BRAKING . . .



gives smoother, safer operation . . . lengthens brake life . . . prevents motor burnouts



Pressure on foot pedal in cab slows down the crane by dynamic braking. Further pressure on pedal applies foot-brake.

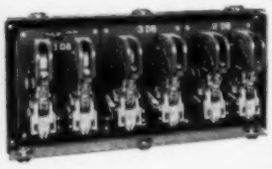
Many advantages have been gained . . . many economics have resulted from the use of electrical braking to slow down the cranes in this plant. In six years of operation, no foot-brake lining required replacement . . . no motor burnouts occurred. These cranes, operating on a 1000-ft. long runway, are easy to stop from high speed . . . or any speed. Braking is quick, smooth, positive, and operators like this less fatiguing method of operation.

When presented with this problem of applying electrical braking to the bridge motions of these cranes, EC&M engineered a simple Controller of Bulletin 921-2942 design, which was easy to install and easy to operate.

EC&M Control Apparatus and Control Engineering are well-known for providing control *engineered* to the task. For crane-bridge drives, EC&M builds standard reversing-plugging controllers, control giving 2 steps of plugging, and emergency dynamic braking control for full protection should power fail.

Call in an EC&M engineer whenever crane control problems arise. He will be glad to discuss control suited to your application.

FAIL-SAFE control for stopping Chargers . . . Ore Bridge Trolleys



The compact 3-contactor Panel, at right above, brings charging machines quickly to rest whenever power fails . . . main power outage, overload relay tripping or failure of collector-shoe circuit. This control has the same advantages for the bridge motions of overhead cranes, larry cars and similar machines.

Of Fail-Safe design, this Control instantly changes the driving motors into self-excited generators, whenever power fails, to produce a cushioned, non-skid, quick stop. Panel-height is low for easy mounting on existing machines . . . ready application on new cranes. For complete facts, ask for Bulletin 921-2926.

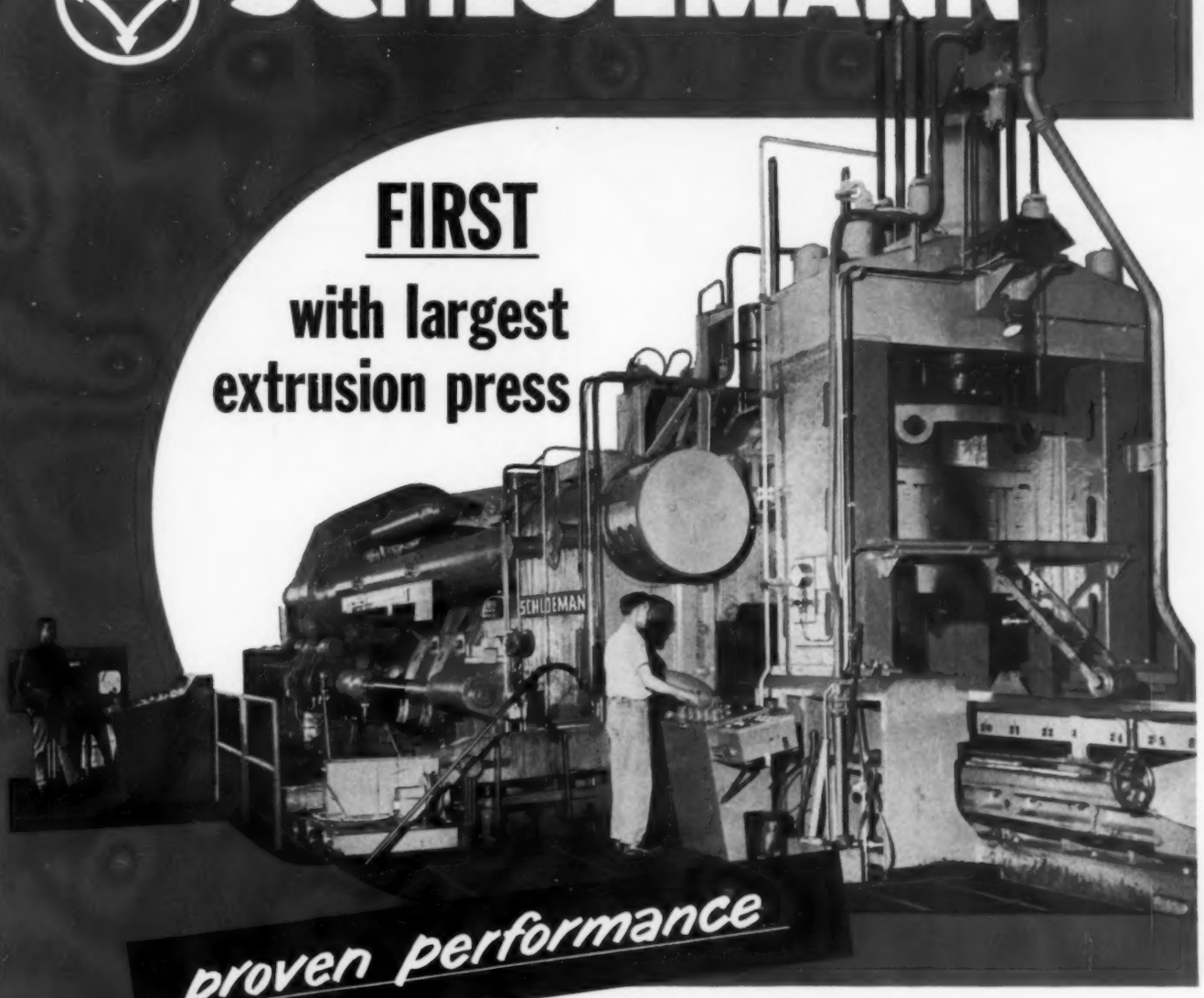
THE ELECTRIC CONTROLLER & MFG. CO.

DIVISION OF SQUARE D COMPANY

4498 Lee Road • Cleveland 28, Ohio

SCHLOEMANN

FIRST
with largest extrusion press



proven performance

14,000 ton Extrusion Press

This Schloemann Press is now completing two years of successful operation. As a key unit of the U. S. Air Force Heavy Press Program, it produces light metal shapes up to 110 feet in length and up to 2500 pounds in weight. Substantial economies are made possible with this unit as well as greater flexibility of product design.

You are invited to discuss with us your extrusion press requirements for any industrial production.

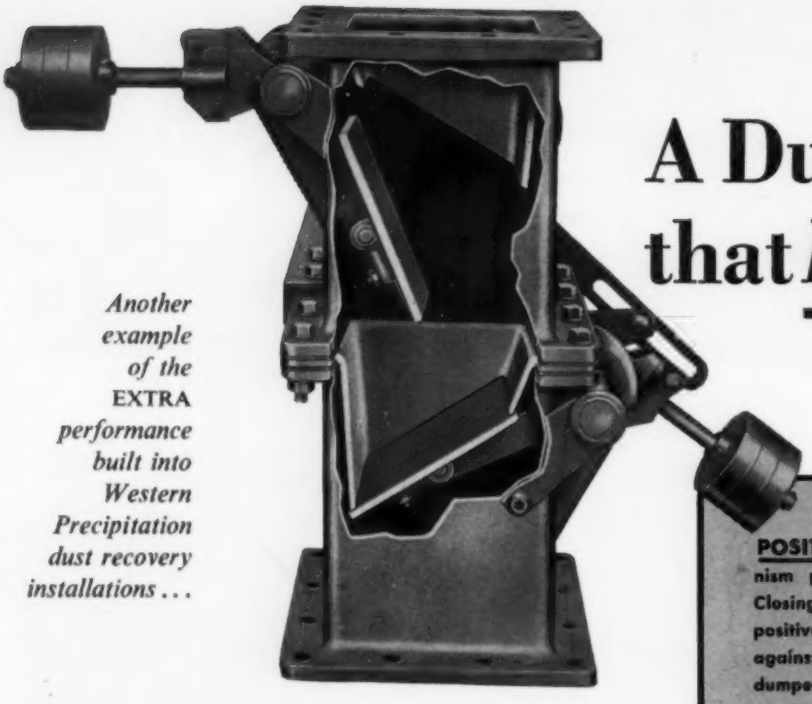
Existing Equipment by **SCHLOEMANN**

Domestic users of equipment built by Schloemann are assured of competent service-engineering, supply of genuine spare, and repair parts. Call a Feller service engineer.

FELLER ENGINEERING COMPANY

1141 Empire Building, Pittsburgh 22, Pa.

Exclusive U.S. Agent



A Dumping Valve that *Really Works**

Another example of the EXTRA *performance built into Western Precipitation dust recovery installations . . .*

No dust recovery installation is better than the valves controlling the dust flow out of the collection hopper – particularly in Sintering Plants where the system operates under substantial vacuum. Poorly-designed valves allow recovered dust to blow back into the system . . . cause troublesome draft losses . . . air infiltration . . . and cut down efficiency of even the best recovery systems.

But – typical of the extra care Western Precipitation puts into *every* recovery installation – is the *Western Precipitation R-1 Dust Valve* . . . an automatic dust valve that is unsurpassed for trouble-free operation and maximum working efficiency. Check the features at right and you'll see why . . .

POSITIVE ACTION: Electric motor-driven mechanism provides positive opening on time-cycle basis. Closing is by gravity – and is adjustable. Thus, valve positively opens even with lightweight materials or against high vacuum . . . closes only after material is dumped.

DOUBLE-FLAP SEALS: Two flaps open and close alternately on a positive cycle to insure continuous clean-out without allowing pressure surges into hopper.

GRAVITY FLUSHING: Gravity safety trip permits each flap seal to open automatically if overloaded, allowing flush-out of excess material. Valves then return automatically to time-cycle operation.

RUGGEDLY BUILT: All parts and seals are designed for heavy-duty service with minimum maintenance. Bearings are sealed against dust – are outboard-mounted to protect against heat and dust. Valve seats and flap seals are easily replaced. Motor is fully sealed and protected.

There are many other unique features your Western Precipitation representative will gladly explain. Or write direct!

The R-1 Valve is typical of the care that goes into every Western Precipitation product. Furthermore, no other organization – domestic or foreign – has had as many years of experience in all phases of recovery methods . . . *electrical* (COTTRELL), *mechanical* (MULTICLONE), *combination* electrical-mechanical (CMP) and *filter* (DUALAIRE). You get an experienced—*and unbiased*—recommendation from Western Precipitation.

* To date 15 steel companies have installed R-1 Valves . . . and every company has re-ordered additional installations!

COTTRELL Electrical Precipitators
MULTICLONE Mechanical Collectors
CMP Combination Units
DUALAIRE Reverse-Jet Filters
HOLO-FLITE Processors

Western Precipitation Corporation

Designers and Manufacturers of Equipment for Collection of Suspended Material from Gases . . . and Equipment for the Process Industries

Main Offices: **1067 WEST NINTH STREET, LOS ANGELES 15, CALIFORNIA**

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Representatives in all principal cities

Bearings, Inc.

ENGINEERS NOW COME IN FRACTIONS!

• We know bearing trouble doesn't keep "office hours" and if it isn't taken care of immediately, losses often mount tremendously with each passing hour of downtime. That's why every Bearings, Inc. branch has emergency night and weekend phone numbers with an experienced bearing engineer standing by to serve you! The Bearings, Inc. sales engineer who calls on you has a list of emergency phone numbers. Ask him for one and keep it handy for immediate use. If you prefer, return the coupon and the emergency phone numbers of the nearest branch will be sent to you.

Bearings, Inc.

OHIO: Akron • Canton • Cincinnati • Cleveland • Columbus • Dayton • Elyria • Goshen • Lima • Mansfield • Toledo • Youngstown • Zanesville
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NEW JERSEY: Camden
Subsidiary: Kentucky Ball and Roller Bearing Co. • Louisville, Ky.

BEARINGS, Inc., 3634 Euclid Ave., Cleveland 15, Ohio

Gentlemen:

Please see that I receive the emergency phone numbers of the branch located near our plant.

NAME _____

FIRM _____

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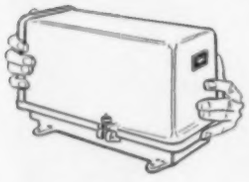
CITY _____ ZONE _____ STATE _____

NEW TAYLOR POTENTIOMETER TRANSMITTER

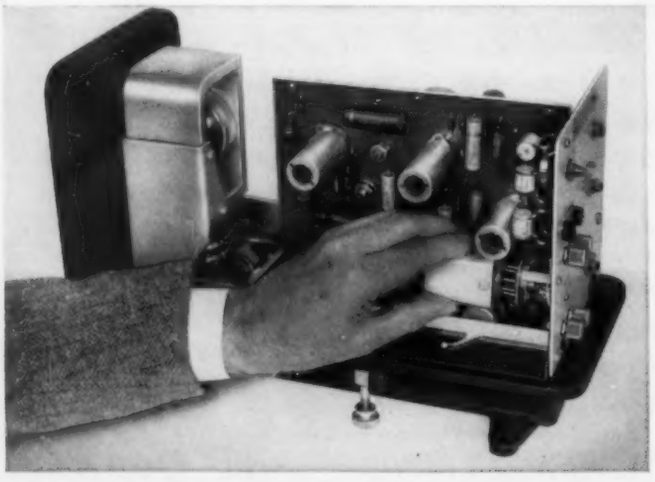
"most practical instrument of its kind!"



TAYLOR'S years of experience and knowledge of the requirements of the processing industries are reflected in this ingenious electronic-pneumatic instrument. The TRANSET* Potentiometer Transmitter can be used with a wide variety of electrical primary elements. It is especially adaptable where conditions require pneumatic controllers and receivers and where conventional measuring circuits have not proved adequate. Check these features:

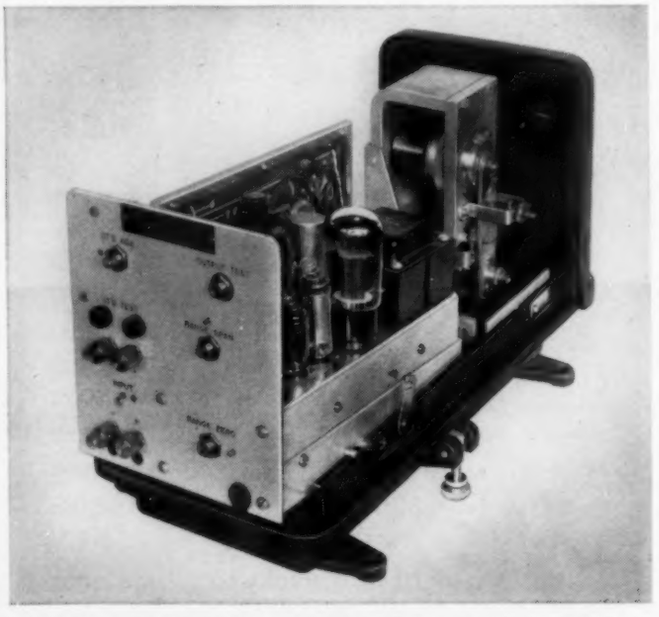
1. Automatically, Continuously Standardized with complete electronic balance, permitting optimum response adjustments. No slide wires or motor drive.
2. High Input Impedance. No need to match resistance of leads.
3. Output Impedance is practically infinite. Its 0-5 milliamp signal can perform multiple auxiliary functions without affecting accuracy of pneumatic signal.
4. Normal Load is automatically inserted when amplifier is removed for service.
5. Modern Printed Circuits insure uniform performance. Test terminals provided to simplify trouble shooting.
6. Test Jack on front panel permits easy monitoring of output current. Convenient pin jacks provided for checking standardization voltage.
7. Purged Cast-aluminum Case is moisture and corrosion proof.

*Reg. U.S. Pat. Off.



Plugging in the Input Circuit Board. It can be quickly adapted for use with different primary elements by simply plugging in the corresponding input circuit; e.g., for thermocouple applications cold junction compensation is provided in the plug-in circuit board. One instrument can therefore be used as a spare wherever a transmitting potentiometer is used.

Plugging in the Transducer. This exclusive plug-in feature applies to both the transducer and the amplifier. Means quick, easy removal for service; minimum instrument down-time; checking can be done in the shop where full facilities are available. Also permits separate calibration.



Plugging in the Amplifier. See how easily units are locked into the chassis. Also note screwdriver adjustment of range span and zero suppression by use of unique potential dividers. Exclusive Taylor vernier adjustment permits resolution of 1 part in 100,000. Transducer can be omitted when only logging and scanning or other auxiliary electrical functions are required.

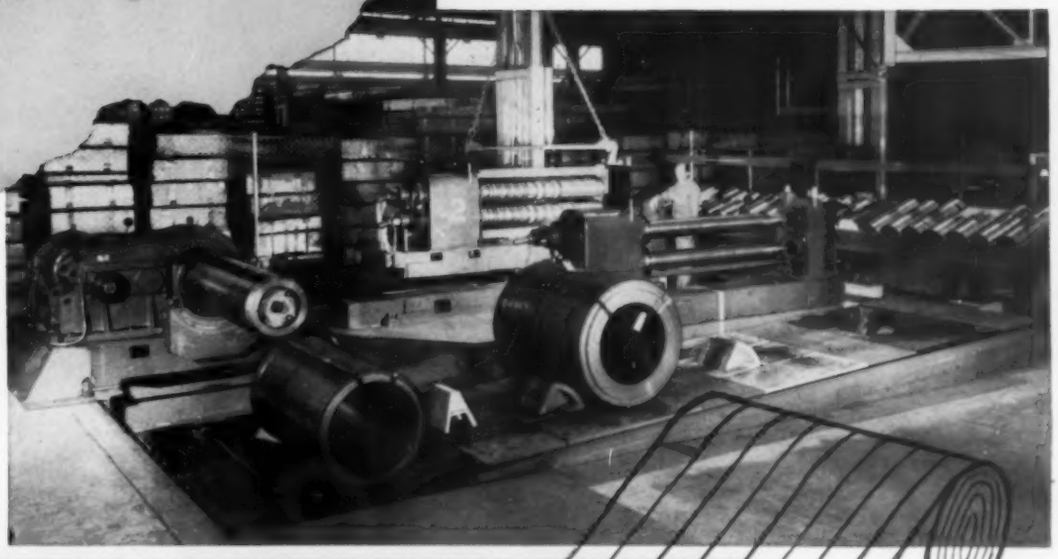
Write for Bulletin **No. 98262.** Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.

Taylor Instruments
MEAN ACCURACY FIRST

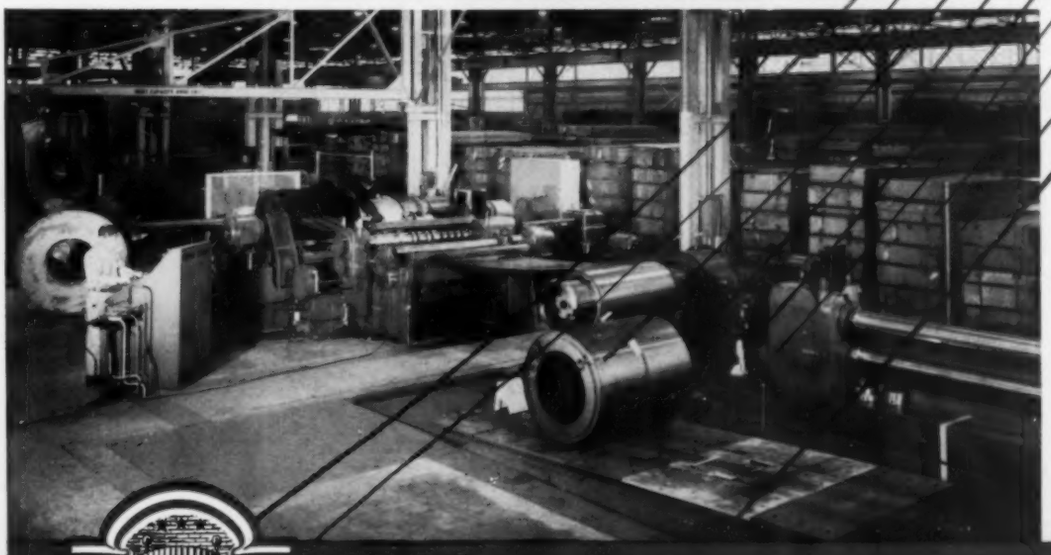
Step Up Production with Stamco Coiling Lines

Stamco Slitting and Coiling Lines will step up your production because they are designed to meet your particular specifications. Years of experience have led to the development of equipment that will meet every slitting and coiling requirement. Stamco slitting and coiling lines are now efficiently handling coils from 500 to 60,000 pounds and are designed to give dependable, maintenance-free service.

Write us, stating your requirements . . . we'll gladly give complete details—no obligation.



View shows coil and traverse, coil pay off reel, coil loading ramp and detachable slitter head.



Overall view of coiling line from entrance end.

LAY YOUR SHEARING PROBLEMS AT STAMCO'S DOOR

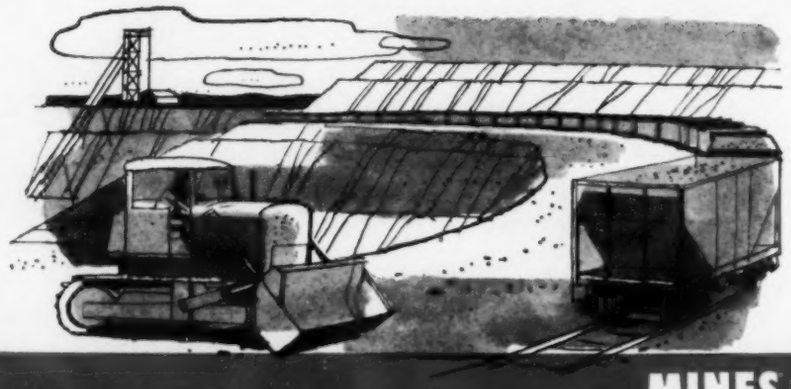
STAMCO, Inc., New Bremen, Ohio

From Mine to Mill

Allis-Chalmers Equipment serves in every part of the Steel Industry... Dependably, Economically

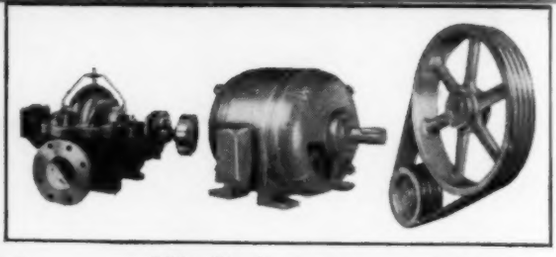
For more than three quarters of a century, Allis-Chalmers has served the steel industry — supplying the equipment needed to produce top quality steel... the manufacturing "know-how" to meet heavy-duty operating conditions... the pioneering spirit to keep up with the changing requirements of the industry. Allis-Chalmers machines are employed, not just in one phase, but all through the steel-making process. For complete information on how Allis-Chalmers can help solve your machinery problems, consult your Allis-Chalmers district office or write Allis-Chalmers, Milwaukee 1, Wis.

Regulex and *Texrope* are Allis-Chalmers trademarks.

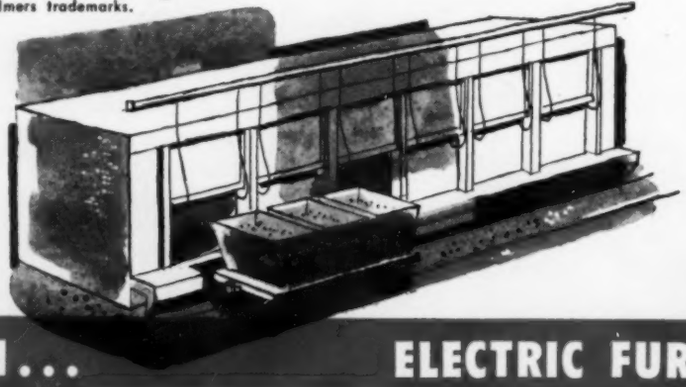


MINES...

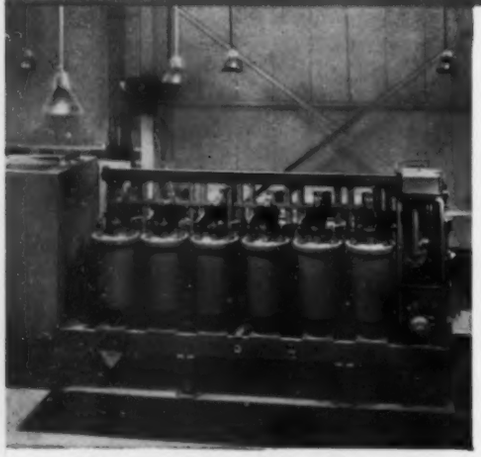
Crushers, grinding mills, vibrating screens engineered and manufactured by Allis-Chalmers crush the ore-bearing rock, grind it to specified size, size and wash metallic ores, stone and coal.



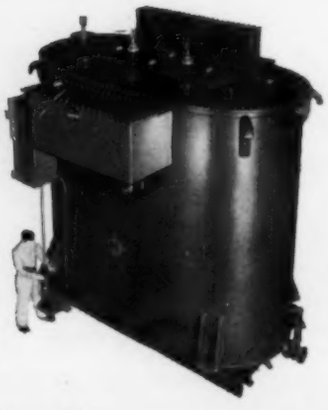
Allis-Chalmers pumps, motors, *Texrope* drives are in wide use throughout the metal industry because of their long life characteristics, low maintenance requirements and great versatility.



OPEN HEARTH... ELECTRIC FURNACE...



Mercury-arc rectifiers furnish constant voltage dc power for material handling in open hearth and other mill operations and for mine haulage. Variable voltage units are supplied for supporting main roll drives.

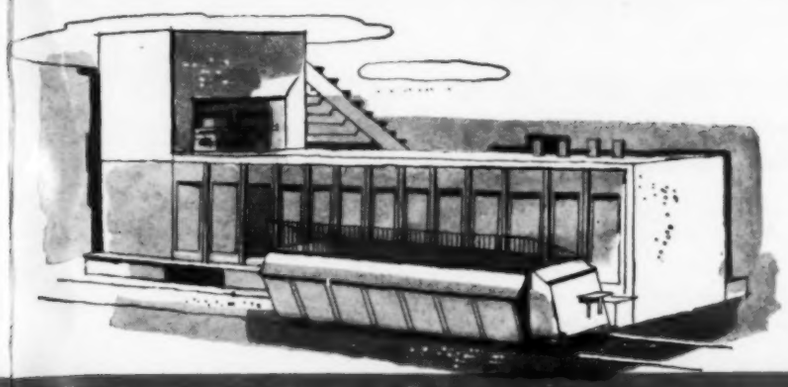


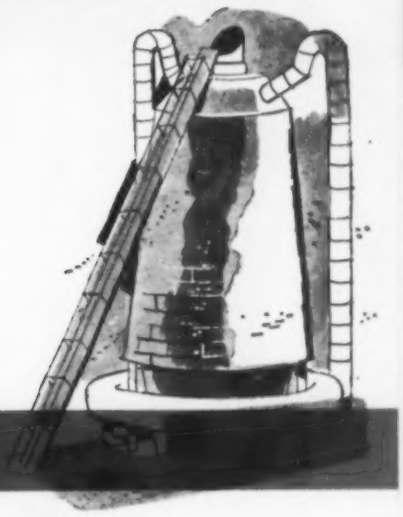
Allis-Chalmers arc furnace transformers are of well-balanced design and extra heavy duty construction — proven in 25-30 years of repeated daily short-circuits in electric furnace operation.

***Regulex* control** balances arc current with arc voltage, almost instantly — maintains desired arc condition automatically.

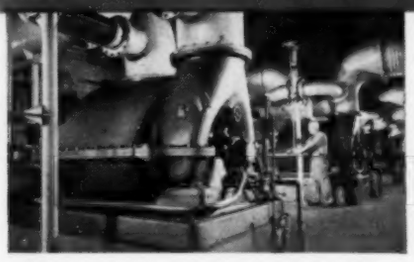
ALLIS-

. It's Allis-Chalmers



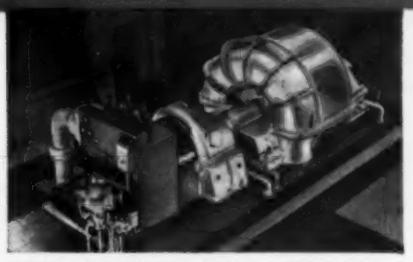


COKE OVEN...



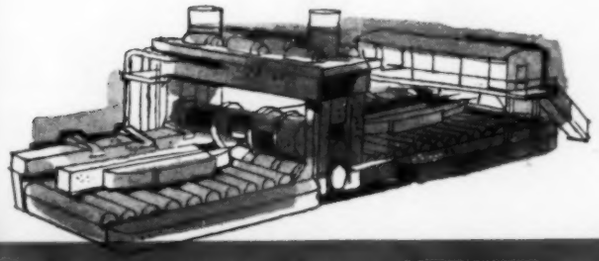
Booster, exhauster or combination service requirements are met by Allis-Chalmers blowers. Photo shows four 23,000-cfm, 5100-rpm, 3.5-psig centrifugal exhausting blowers in a western steel mill.

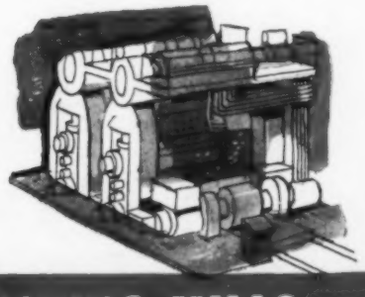
BLAST FURNACE...



Blast furnace blowers furnished by Allis-Chalmers meet blast furnace requirements. The 75,000-cfm, 30-psig centrifugal blower shown here has been in service since 1942. It is driven by an 8500-hp steam turbine.

Allis-Chalmers axial blowers are designed for high efficiency blast furnace duty. They are smaller, easier to install — save $50,000 or more in steam per year. A-C also builds constant efficiency rotary compressors.





BLOOMING MILL...

Motor room photograph shows Allis-Chalmers switchgear, control, constant and variable voltage motor-generator sets, *Regulex* m-g sets, liquid rheostat, and twin-drive motors in use in a midwestern steel plant.

FINISHING MILLS...

Hot strip, cold reduction, temper, rod and wire mills, and annealing and pickling lines employ Allis-Chalmers control, power equipment and drive motors for dependable operation.

Other Equipment

Besides the power utilization and conversion equipment illustrated, Allis-Chalmers also supplies power generation and distribution requirements from mine to mill.

For power generation, A-C builds steam turbine-generator units, surface condensers, water conditioning equipment, pumps, motors, and control. Also hydraulic turbines, generators, governors, and valves. For power distribution, A-C furnishes transformers, voltage regulators, circuit breakers, switchgear, and substations.

Throughout this wide range of products, you can depend on Allis-Chalmers for equipment engineered to meet your exact needs.

CHALMERS

A-C ALLIS-CHALMERS

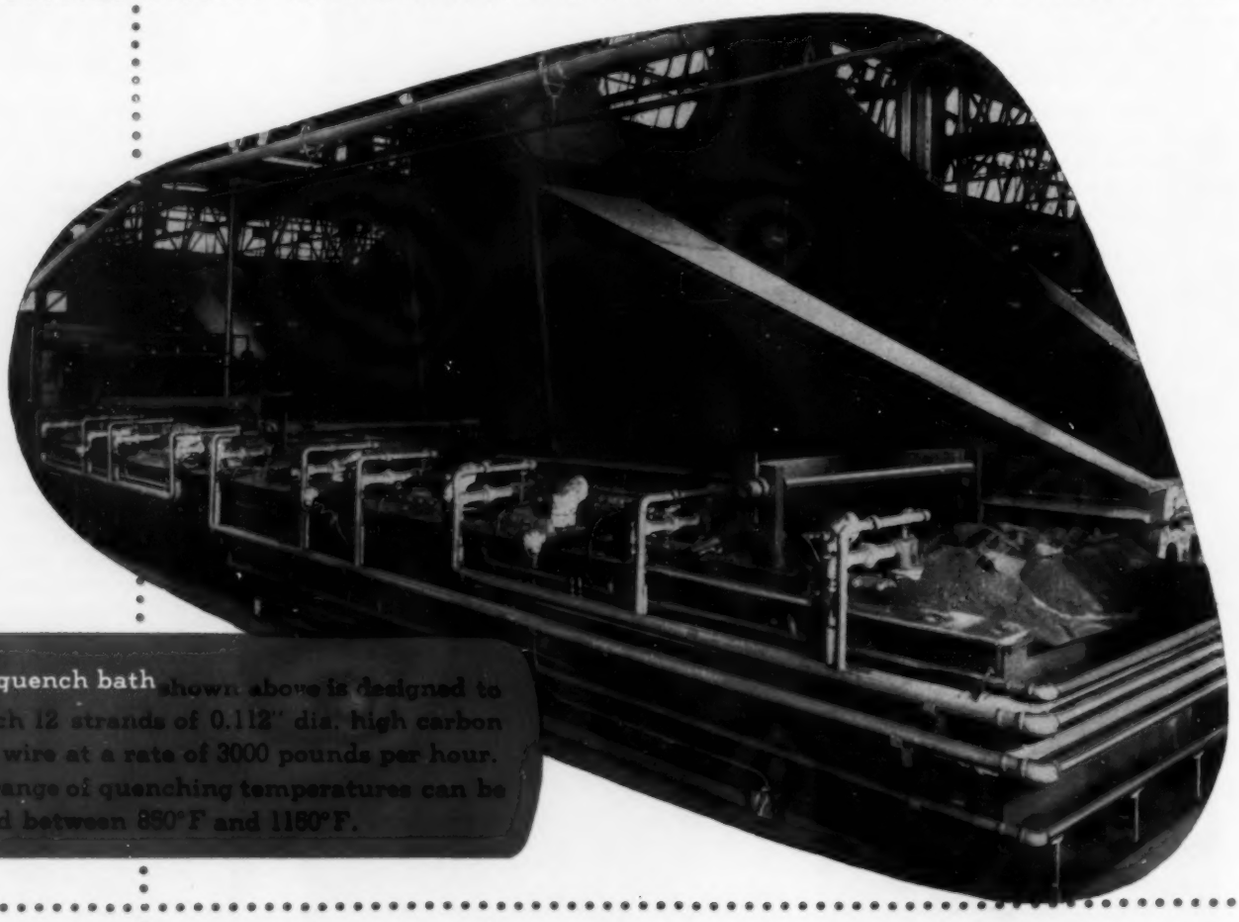
A-4907

DREVER

IMMERSION TUBE HEATED LEAD QUENCH FOR WIRE PATENTING

This 3-zone 30 ft. long gas-fired immersion tube heated lead quench forms part of a continuous patenting, cleaning and coating line for high carbon steel wires.

The multi-zoned lead quench is not only heated by gas-fired immersion tubes, but also utilizes the same immersion tubes with forced air cooling to maintain uniform temperatures throughout the bath. A specially designed control system automatically proportions the gas heating and/or air cooling of the tubes.



The quench bath shown above is designed to quench 12 strands of 0.112" dia. high carbon steel wire at a rate of 3000 pounds per hour. The range of quenching temperatures can be varied between 850°F and 1150°F.

DREVER COMPANY

RED LION RD. and PHILMONT AVE., BETHAYRES, PA.

32

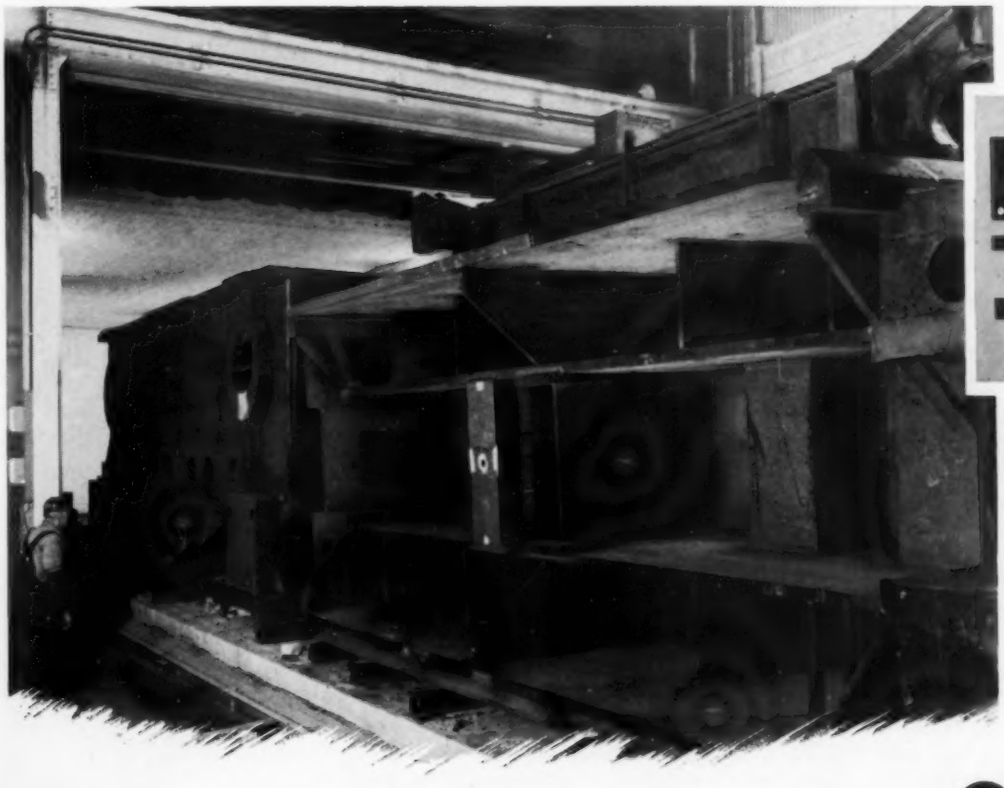
How Morgan stress relieving insures maximum design strength

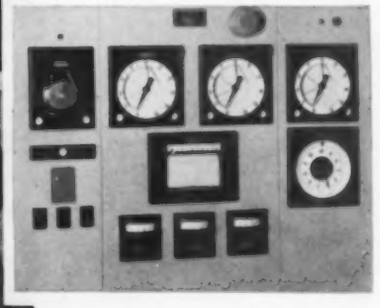
• STRESS RELIEVING is one of many reasons why Morgan cranes provide longer, completely safe service under *any* operating conditions. Trolley frames, end carriages, trucks, drums, bearing caps, stripper barrels and rams, pit rams . . . all are stress relieved in Morgan's huge furnace capable of handling loads up to 250,000 pounds.

Morgan's stress relief furnace, one of the largest in the world, can raise temperatures 200 degrees Fahrenheit per hour up to 1750° F.

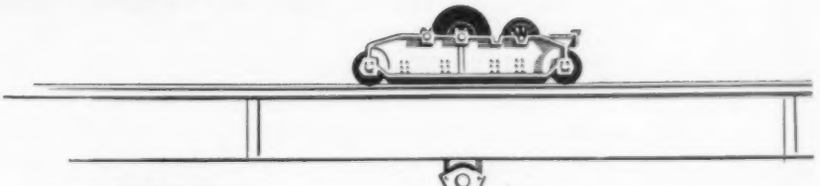
Stress relieving is still another example of the advanced design and construction features that make Morgan cranes the best in the business.

Performance records prove that Morgan cranes cost less to operate and maintain. Let our representative show you how to save the most by buying the best . . . Morgan!





• Stresses built up in welding process are relieved in this 52 x 20 x 15 foot furnace. The 48 dual fuel burners are divided into three temperature zones, each zone controlled by an electronic potentiometer. Safety devices include high limit temperature controls, fuel shut-off valves. Combustion safeguards insure against over-heating.



The Morgan Engineering Company, founded in 1868, manufactures overhead electric traveling cranes, gantry cranes, open hearth special cranes, plate mills, blooming mills, structural mills, shears, saws, and auxiliary equipment.

THE
MORGAN
ENGINEERING CO. *Alliance, Ohio*

Now...protection against dust, dirt, and chipping! The new NATIONAL TRADE-MARK electrode end-caps!

National Carbon's new protective end-caps perform a dual function. They screen out dust and dirt from electrode socket... protect against end-face chipping—two common causes of impaired electrical performance. They also give better visibility, quicker identification, easier handling and storage of graphite electrodes from 12-24 inch diameter. National Carbon's new electrode sales and service program serves you in many ways:

HERE'S HOW:

Product Quality: Recognized as the industry's highest.

Technical Service: Largest, best qualified group of its kind... organized to extend the service function regularly furnished by field salesmen. Repeatedly, this service has recommended improvements in electrode operation...improvements which have resulted in more efficient power utilization, better joints and joining procedure, and attractive dollar savings for customers.

Free Electrode Training Program: Conducted in your own plant or any other mutually convenient location. Streamlined demonstration program familiarizes your men with the important *do's* and *don't's* of electrode usage.

FOR ELECTRODES AND ELECTRODE SERVICE . . . RELY ON NATIONAL CARBON COMPANY

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30 East 42nd Street, New York 17, N. Y.

Sales Offices: Atlanta, Chicago, Dallas, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco
In Canada: Union Carbide Canada Limited, Toronto.

Personnel News...

William L. Cressman, former manager of eastern sales for Armco Steel Corp., has been appointed assistant general manager—Product Divisions for Jones & Laughlin Steel Corp.

William H. Fulwider has been appointed superintendent of the Electrical Division, Acme Steel Co. In addition, **Paul W. Coffman** was named superintendent of the Cold Mill Division. Before joining Acme Steel Co. in April of this year, Mr. Fulwider was with the Steel Division of Ford Motor Co. as chief draftsman in the Plant Engineering Department. From 1950 to 1954 he was supervisor of engineering in the Plant Engineering Department of Ford's Aircraft Engineer Division. For two years, 1948 and 1949, he was an electrical engineer with the Armco International Corp. Prior to that he was with Cia Siderurgica Nacional, Brazil and Inland Steel Co. Mr. Coffman joined Acme in 1950 as assistant superintendent of the Cold Mill Division. From 1945 to 1950 he was with National Steel Co. of Brazil as superintendent of the Flat Rolling Division. During 1944 and 1945 he was a technical advisor with Mesta Machine Co. From 1938 to 1944 he was a Cold Strip Mill Specialist in England, working in that capacity first with Richard Thomas & Co., Ltd., and then with John Summers & Sons, Ltd. Before going to England, he was with Bethlehem Steel Co. as a metallurgical analyst.

C. E. "Emil" Miller has been named assistant superintendent of the Industrial Engineering Department, Colorado Fuel and Iron Corp.'s Pueblo plant. Mr. Miller was formerly a senior industrial engineer. Mr. Miller became associated with CF&I in 1929 when he joined Pueblo's Engineering Department. He later transferred to Combustion Engineering, and, in 1947 to Industrial Engineering.

Enders M. Voorhees has retired as chairman of the finance committee of United States Steel Corp., and **Robert C. Tyson** has been elected to succeed him. Mr. Voorhees, who has reached the normal retirement age, will continue as a director, member of the finance committee and consultant. Mr. Tyson has been associated with U. S. Steel since 1939 in various capacities, the most recent of which were comptroller and vice chairman of the finance committee. An executive committee was also created by action of the board of directors and **Clifford F. Hood,** president of U. S. Steel was elected chairman of the executive committee. The executive advisory committee created a year ago was discontinued. Former president and chairman of the board, **Benjamin F. Fairless,** who had been chairman of the executive advisory committee, will, in addition to his duties as consultant, serve as special advisor to the board of directors.

Therman B. Duckworth, former assistant blast furnace superintendent, Tennessee Products and Chemical Association, has been appointed assistant superintendent, blast furnace department of Jones & Laughlin Steel Corp.'s Aliquippa Works. Mr. Duckworth succeeds **A. T. Sadler,** who earlier was named superintendent of the Blast Furnace Department.

L. Ovid Sperry has been appointed assistant superintendent of the North Plant Department, Granite City Steel Co. **David W. Boyles,** a senior industrial engineer, succeeds Mr. Sperry as assistant to the superintendent. Mr. Sperry started with Granite City in 1934, and became assistant to the superintendent of the North Plant Department last year. Mr. Boyles started with the company in 1951.

Dick W. Pehl was named superintendent, mechanical maintenance, at Kaiser Steel Corp. He was formerly assistant superintendent, mechanical shops, and has been with the company since 1949 when he joined Kaiser as a production assistant.

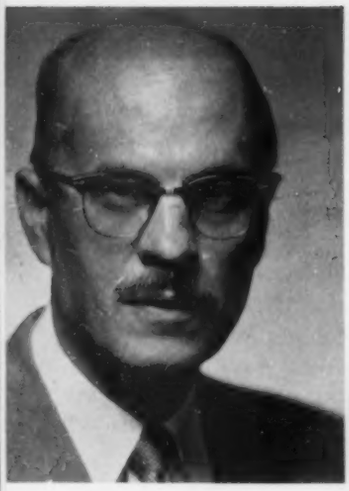
Thomas T. Crowley has been named general manager of Crucible Steel Co. of America's newly formed Spring Division. Mr. Crowley was formerly staff assistant to the senior vice president at Crucible. In his new position, Mr. Crowley is responsible for all phases of the division's operation including production, sales, personnel, and administration. Prior to joining Crucible in 1953, Mr. Crowley was assistant to the president of Inland Steel Container Co. Previous to that he was a member of the Economic Cooperation Ad-

WILLIAM L. CRESSMAN

WILLIAM H. FULWIDER

PAUL W. COFFMAN

C. E. "EMIL" MILLER



JOHN R. DAVEY

JOHN R. WALL

JOHN A. HILL

ANDREW F. KRITSCHER

ministration's Special Mission to the United Kingdom. He joined the Mission in London in October, 1948, as its steel advisor. Before his ECA assignment Mr. Crowley was associated with the United States Steel Corp.

John R. Davey was named manager of the Metallurgical Department, Acme Steel Co. He joined Acme Steel in August, 1954 as assistant chief metallurgist. From 1952 until 1954 he was a technical assistant for the rolling mills of United States Steel Corp. Prior to that he was superintendent of the Tin Plate Department of Jones and Laughlin Steel Corp. and a metallurgist with both Ohio Ferro-Alloys and Empire Steel Corp.

John R. Wall has been appointed assistant general traffic manager of Republic Steel Corp. Mr. Wall is currently chairman of the Freight Traffic Committee, Central Territory Railroads, and will assume his duties with Republic on June 1.

John A. Hill has joined the Research and Development Department of Jones & Laughlin Steel Corp. as staff assistant to the vice president-research and development. Mr. Hill came to J&L from the Minneapolis-Honeywell Regulator Co. Previously, he had been assistant dean of the College of Engineering at New York University.

Andrew F. Kritscher has been appointed manager of engineering for Kaiser Aluminum & Chemical Corp. In this newly created position he will coordinate all engineering activities for the corporation. Mr. Kritscher joins Kaiser following more than 18 years of engineering and production experience with United States Steel Corp. His association with U. S. Steel covered a wide range of assignments in the company's National Tube Division, where he most recently served as assistant chief engineer. He is a former director of the AISE.

Herman F. Kaiser has been promoted to superintendent of the blooming mill of Republic Steel Corp.'s Canton, Ohio, plant. He succeeds **Ben C. Wells,** who died recently. Mr. Kaiser has been assistant superintendent at the blooming mill since 1954. He joined Republic in 1928 and has held a variety of supervisory positions at the Canton steel plant.

Sidney E. Graeff has become affiliated in a consulting capacity with Salem-Brosius, Inc. During the past 20 years, Mr. Graeff has been in England, and prior to that time he was associated with Armco Steel Corp. He is a director of the Steel Company of Wales and a consultant to that company as well as Richard, Thomas and Baldwin, Ltd. For many years he was also a director of Richard, Thomas and Baldwin, Ltd. He is also associated with Hatfield Steel Co., Ltd., and British Timken Co., Ltd., and he is a consultant with Armco International Corp.

ROBERT W. MARVIN

Robert W. Marvin was elected a vice president of Dravo Corp. He is a director of the corporation and general manager Engineering Works Division.

Samuel A. Ott has been appointed works manager of the Claymont, Del., plant of the Colorado Fuel and Iron Corp. Prior to joining CF&I Mr. Ott was superintendent of the Midvale Co. Previously he was chief metallurgist and assistant to the vice president of the Penn-Ohio Steel Corp., vice president and general sales manager of the Pittsburgh Alloy Corp., and superin-

This plant's stockpile is worth millions--

yet it doesn't cost a cent!

The "wild blue yonder"—the free and limitless atmosphere — is the stockpile for Air Products Oxygen (and/or Nitrogen) Generators. There are no delivery problems for this inexhaustible raw material. There are no price fluctuations and no shortages to trouble the owners of these plants.

The method is basic. The production of oxygen and nitrogen from air is accomplished by "Low-Temperature Processing". The air is liquefied by refrigeration and the nitrogen is drawn off at its boiling point (fractional distillation) leaving the pure oxygen product.
Your own "On-Location" Generator can provide you with a continuous supply of oxygen regardless of your requirements —including moderate to large tonnage users. We will furnish and install a complete facility at no capital investment on your part—on a lease basis including a purchase option. If you prefer, we will operate and maintain the facility and guarantee your oxygen savings.

Send us details regarding your requirements and expected future needs. We will then give you a realistic estimate of the savings you can expect with an Air Products Generator installed in your plant.

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Air Products
INCORPORATED
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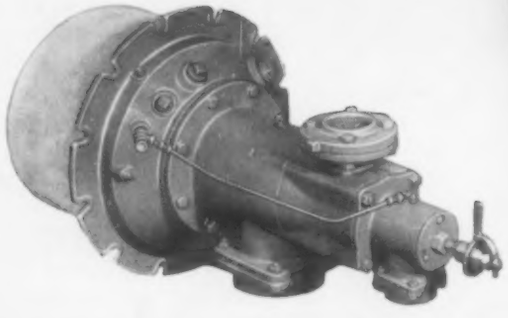
successful installations

the ultimate in burner performance....

NORTH AMERICAN'S

FIRE-ALL

DUAL-FUEL



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FOR MAINTENANCE-FREE OPERATION

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since 1917

the **NORTH AMERICAN** mfg co

Combustion Engineers

4455 East 71st St. • Cleveland 5, Ohio

tendent of the open hearth of the Follansbee Steel Corp., Toronto, Ohio, and was also associated with the Phoenix Iron Corp.

S. W. Crisman is now Pittsburgh district manager for Elliott Co. He succeeds **J. H. Strickler,** who died March 30. Mr. Crisman came with Elliott in 1935 and was assigned as a field engineer in the Pittsburgh district office in 1937. He was appointed assistant district manager in 1953.

L. J. Dusenbury has been named head of the Proposal and Contract Department, Western Precipitation Corp.

Ehrman S. Reynolds was named senior engineering representative, Industrial Division, Socony Mobil Oil Co., Inc. Mr. Reynolds will be in charge of lubricants for industrial and marine gears as well as all heavy industry. **Dalton D. Schnack** formerly with the Chicago Industrial Division will assume Mr. Reynolds' former duties as engine builders representative in western Pa. and western N. Y.

James Freese was named general production manager of all plants of the Timken Roller Bearing Co., and **Charles L. Richey** was named assistant general production manager. Mr. Freese started with Timken in 1929. In 1937 he was promoted to assistant production manager of the Steel and Tube Division, and in 1942 to the position of manager of production of the Steel and Tube Division. In 1953 Mr. Freese was named assistant general production manager of all plants, which post he held until his recent appointment as general production manager. He succeeds **James Reid,** retired.

William P. Snyder, Jr., chairman, Crucible Steel Co. of America, announced his desire to be relieved of the active management of the company's affairs, a position he has held since 1944. **Joel Hunter**, president since May, 1954, will assume the responsibilities of the general management of Crucible's activities. At the request of the board of directors, Mr. Snyder will continue as chairman, presiding at meetings and acting in an advisory capacity.

A. B. Drastrup has been appointed vice president of the Joy Manufacturing Co. Mr. Drastrup formerly was president of the A. M. Byers Co.

Sherman R. Lyle was appointed district manager of Timken Roller Bearing Co.'s Steel and Tube Division offices in Cleveland. He replaces **R. P. Donnell** who becomes district manager of the division's New York City territory. At the same time, **Ross Hershey,** formerly a sales engineer in the company's Detroit office, was named district sales manager of the company's Buffalo district.

Samuel W. Gearhart, Jr., has been appointed sales and service engineer of the Birdsboro Steel Foundry and Machine Co. He joined the company after serving nine years as metallurgist and supervising metallurgical engineer for Baldwin-Lima-Hamilton Corp.

B. B. Lanier, Jr. has been named to head export sales for Laclede-Christy Division, H. K. Porter Co., Inc.

H. G. Ebdon, vice president and general sales manager of Combustion Engineering, Inc., has been named executive vice president of the board of directors. Mr. Ebdon joined the company in 1917 and since 1925 has served successively as manager of the proposition department, sales engineer, assistant general sales manager and general sales manager. In 1950, he was elected a vice president.

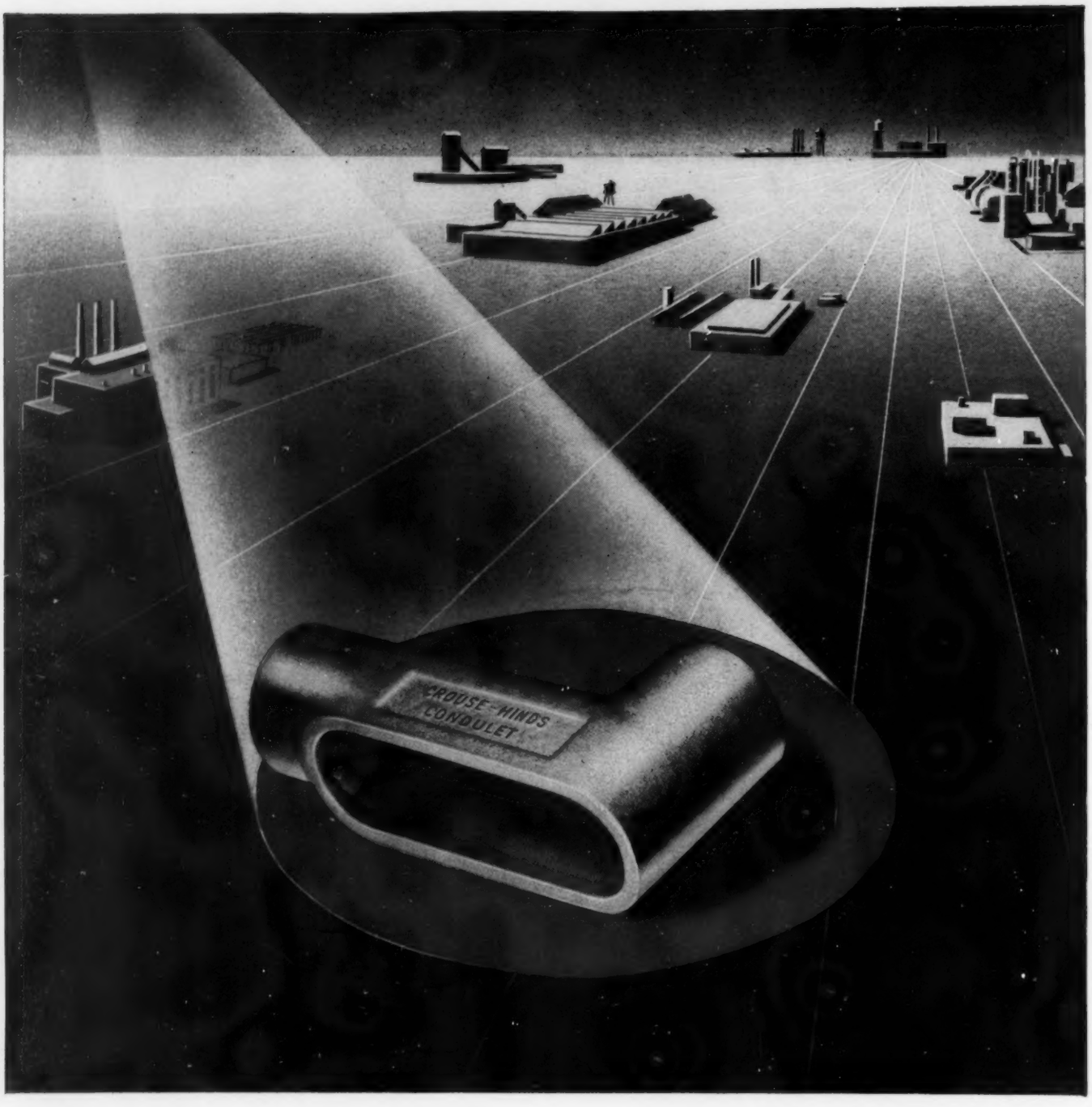
R. S. A. Dougherty has retired as manager of research, Bethlehem Steel Co., ending a connection that began in 1919. **John C. Marsh,** formerly assistant manager of research, succeeds Mr. Dougherty. **J. E. Eberhardt** and **Paul Ffield** were named as assistant managers of research. Mr. Dougherty joined Bethlehem in 1919. He was made manager of patents in the following year and manager of research in 1926. Mr. Marsh joined Bethlehem's research staff in 1942. The author of several technical works and papers, Mr. Marsh holds the Hunt Medal of the American Institute of Mining and Metallurgical and Petroleum Institute and was the Institute's Howe Memorial Lecturer in 1955.

S. W. CRISMAN

L. J. DUSENBURY

EHRMAN S. REYNOLDS

DALTON D. SCHNACK



Still the standard of quality in rigid conduit fittings

Condulets* have been widely imitated since Crouse-Hinds introduced them more than 40 years ago . . . *and that's all to the good!*

Imitation by others has kept us on our toes . . . made us constantly improve our product to stay *ahead* of competition.

As a result, most conduit fittings today incorporate many basic features pioneered by Crouse-Hinds—but lack certain refinements that put Condulets in a class by themselves, head and shoulders above the rest.

What other fittings, for example, include these improvements:
. . . an ingenious *Cover* design that eliminates protruding screws or ears in the housing—common causes of cable damage.
. . . a longer *Hub* that permits full tightening of conduit and fitting without causing conduit to bottom on the integral bushing.
. . . a corrosion-resistant Feraloy *Body* plus a triple-layer *Finish* that exceeds Federal and UL specs. for lasting protection.

These years-ahead Condulet features have yet to be equalled. You get them in all 45 types of Obround Condulets ranging in size from ½" to 6". See your Crouse-Hinds distributor. Crouse-Hinds Company, Syracuse 1, New York.

*Registered

CROUSE-HINDS COMPANY

WYN McCOY

DONALD P. GARDNER

RAYMOND L. HOWERTON

CLARK HAGUE

Wyn McCoy, formerly district manager, Industrial Division of the Timken Roller Bearing Co.'s Chicago territory, has been promoted to sales promotion manager, Industrial Division at Canton, Ohio.

Donald P. Gardner was appointed field sales engineer of Loewy-Hydropress Division of Baldwin-Lima-Hamilton Corp. Mr. Gardner will maintain headquarters in Detroit, Mich., and will serve the Mich., and western Ohio areas.

Raymond L. Howerton has been promoted to the position of assistant manager, Sales Promotion Department, Hyster Co.

Clark Hague now heads the Hague Regulator Corp. of Orangeville, Ohio. Mr. Hague was with Askania Regulator Co. for more than 25 years.

James Gillis has been named manager of the newly-opened Pittsburgh office of the Ohio Knife Co. He was formerly in the company's Detroit office. He will have as his assistant, **Arthur Doud, Jr.**

Al W. Roth has been appointed manager of the new Large Propeller Division of Aerovent Fan Co., Inc. Mr. Roth has served in a sales engineering capacity for the company throughout the southwest and will continue to maintain offices in Tulsa, Okla., and at Piqua, Ohio.

Robert W. Keenan was appointed to the position of assistant manager of the order and production planning department of Sharon Steel Corp.

William C. Campbell, until recently general sales manager and assistant secretary of National Mines Service Co., has joined Joy Manufacturing Co. as manager of warehouse operations. Mr. Campbell started his career with U. S. Steel as an industrial engineer, later joined National Mines Service Co. as manager, Joy Division.

W. Frank Bort has been named manager of industrial construction and **Stanley Kimball** has been appointed manager of heavy construction for Kaiser Engineers Division of Henry J. Kaiser Co. Mr. Bort will have charge of all industrial construction carried on by Kaiser within the continental United States. Mr. Kimball will supervise heavy construction work coupled with engineering design on joint ventures carried out by Kaiser Engineers and other firms.

Charles L. Holbert has been appointed executive vice president of H. K. Porter Co., Inc. Mr. Holbert, who will be operating head of Porter, succeeds **Clarence R. Dobson** who has retired. Mr. Dobson, who joined Porter in 1946, will serve as a consultant to the company.

John P. Kinville has retired as vice president, Michigan Limestone Division, U. S. Steel Corp., after 40 continuous years of service.

Howard Scheidle was named district sales manager in Philadelphia for Electric Controller & Mfg. Co., Division of Square D Co. Mr. Scheidle who has been with the company's Pittsburgh office for the past six years, first joined Electric Controller in 1949.

Rhea P. Lapsley was appointed vice president in charge of research and product development of the Okonite Co.

James H. Dempster has been named general manager of Republic Flow Meters Canada Ltd.

K. C. Cox was elected as a member of the board of directors of Dravo of Canada Ltd. Mr. Cox has been chief engineer of Dravo of Canada Ltd. since 1953. He had previously served Dravo Corp. in various engineering capacities for more than 13 years.

Frank E. Stehlik has been appointed general manager of General Electric Co.'s Low Voltage Switchgear Department at Philadelphia, Pa. He succeeds **R. H. Jones,** who has been promoted to general manager, Air Conditioning Division.

John G. Frischkorn has been appointed district sales manager by the Cleveland Tramrail Division of the Cleveland Crane & Engineering Co. His territory includes parts of W. Va., Pa., N. Y., and Eastern Canada.

Mr. Frischkorn has had sixteen years' experience with Cleveland Tramrail as design engineer for overhead materials handling equipment. He also was with the Euclid Crane & Hoist Co. for six years where he was chief engineer and later general sales manager.

Bart A. Rossfeld has been appointed vice president of the National Bearing Division of American Brake Shoe Co., and **Albert L. Hunt** has been appointed general manager of the division's St. Louis, Mo., plant. Mr. Rossfeld was formerly assistant vice-president of the division. He joined the company in 1923 and has held various production and administrative positions, including assistant division works manager. Prior to his new appointment, Mr. Hunt was manager of industrial sales for National Bearing.

Simon J. Tombaugh has been named manager of the East Central District of the General Electric Co.'s User Industries Sales Department, with headquarters in Cleveland, Ohio. He succeeds **Edwin H. Howell,** who has been elected a commercial vice president with headquarters in Dallas, Tex. **John T. Stone** will succeed Mr. Tombaugh as manager of User Industries Sales in the Indianapolis, Ind., area. The department is a part of the company's Apparatus Sales Division, with headquarters in New York City.

Ernest L. Roberts, Jr. has been appointed a representative of the Ohio Knife Co. Mr. Roberts will serve the metalworking industry within a 200 mile radius of Pittsfield, Mass.

Alfred A. Augustine has been named chief engineer of Loftus Engineering Corp. Mr. Augustine was associated with Jones and Laughlin Steel Corp. and Union Mining Co. prior to joining the Loftus organization in 1940.

Roger M. McCray was appointed product sales manager, Kennametal Inc. Mr. McCray had been a sales representative in the Buffalo area for Kennametal since 1952, prior to which he was associated with the Corry-Jamestown Corp., and the Elliott Co.

Obituaries

Ray Ulbrich, assistant superintendent, mechanical maintenance, Kaiser Steel Corp., Fontana, Calif., died November 16, 1955.

Francis Mohler, former president of Patterson-Emerson-Comstock, Inc., died May 2. Mr. Mohler helped found the Patterson-Emerson-Comstock firm in 1946. Before this time, he was employed by General Electric Corp., for over 20 years and won its Coffin Award for advances in electrification of the steel industry.

LEE N. HODSON

Lee N. Hodson, Sr., president and general manager of the Hodson Corp., died March 22.

Louis J. Ehlinger, 75, former assistant chief engineer of Alan Wood Steel Co. who retired in August, 1955, died April 27, 1956.

THE ELECTRIC FURNACE CO. Salem, Ohio
EF
Gas Fired, Oil Fired and Electric Furnaces.

HEAT PROCESSING
FURNACES
for the Steel Industry

Equipment for annealing, normalizing, galvanizing and other heat processing of high and low carbon steel, stainless, silicon and other alloys—strip, sheet, wire, tubing and other ferrous and non-ferrous products.

Submit your problems to EF engineers
See our advertisements in preceding and following issues

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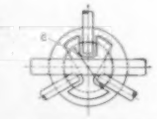
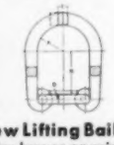
Salem - Ohio
GAS-FIRED, OIL-FIRED AND ELECTRIC FURNACES
FOR ANY PROCESS, PRODUCT OR PRODUCTION

New TM ALLOY STEEL downtown
MAGNET CHAIN
lasts 5 to 15 times longer
than conventional types!



Locating Plate takes larger joiner links with squared top sections — keeps chain legs separated at 120° centers to reduce friction, twisting and gouging.



New Lifting Bail provides larger opening for hook. Heavy, squared-type Alloy Steel construction assures longer life.

- Locating plate keeps legs at 120° centers—eliminates wear —increases life of assembly!
- Made of Taylor Made Alloy Steel Chain—has twice the tensile strength of wrought iron.
- Resistant to shock, grain-growth, work-hardness.

Patent No. 2626175

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ONE OF A SERIES . . .

What makes a cylindrical roller bearing good?

WELL-MADE, VERSATILE OUTER RACES

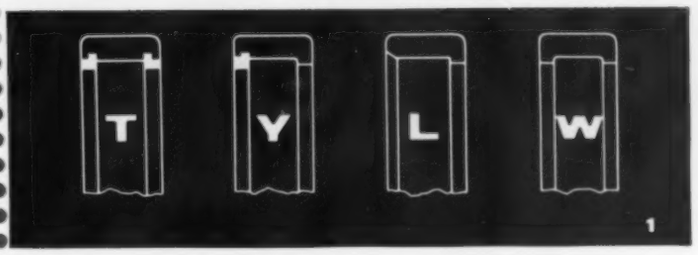
Outer races are vital parts of all roller bearings, except where housings can provide hardened and ground operating surfaces. In housings of aluminum, cast iron or un-heat-treated steel, outer races assure a dependable roller pathway.

While the outer race is not normally the critical member of the bearing, it can still suffer fatigue failure, like all objects subjected to stress repetitions. Therefore HYATT outer races are manufactured with the same scrupulous care that we apply to inner races and all other components of HYATT Bearings. We supply a wide variety of outer races, which makes HYATTS versatile enough to fit practically any design requirements. Some of these application and operating advantages are briefly covered at the right.

You'll find more details in HYATT General Catalog No. 150, or your nearby HYATT Sales Engineer will gladly help you choose the type best suited to your needs. Remember, HYATT is America's *first* and *foremost* maker of roller bearings. Hyatt Bearings Division of General Motors, Harrison, New Jersey.

GM GENERAL MOTORS

HYATT ROLLER BEARINGS

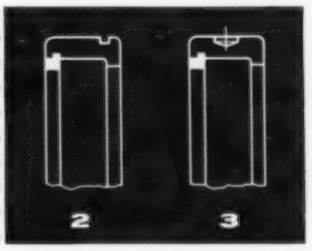


1. OUTER RACE TYPES

HYATT Hy-Load outer races are available in a variety of standard configurations (Figure 1). W, L and Y races have solid flanges, which sustain light or intermittent thrust loads. T and Y races with internal snap rings have equal radial load-carrying capacity but are not recommended for applications under continuous thrust. T, Y, L and W races may all be mounted using roller ends against the solid shoulder or internal snap ring for purposes of locating the outer race axially.

2. CIRCUMFERENTIAL LOCATION

An ample choice of outer race locating methods may be used with HYATT Hy-Loads. Circumferential location is often by a press fit. (Generally the rotating race should be applied with a press fit and the stationary race with a push fit.) When a push fit is used, axial clamping against the race ends provides satisfactory circumferential location. Positive circumferential location is provided by an outer race dowel.



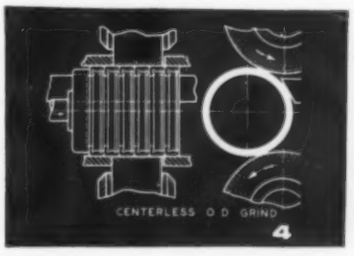
3. AXIAL LOCATION

Axial location of an outer race is usually by pressing or pushing the race to a housing shoulder. The race may be prevented from "walking out" of the housing bore by the flange or snap ring operating against the roller ends. Axial clamping against a housing shoulder or snap ring provides positive axial location. However, if a shoulder is not available in the housing, an auxiliary holding device such as an external snap ring or an outer race dowel is needed. HYATT Hy-Load Bearings can be supplied to original equipment builders with outer races having a snap ring groove (Figure 2) or a blind dowel hole (Figure 3), at moderate increase in cost.

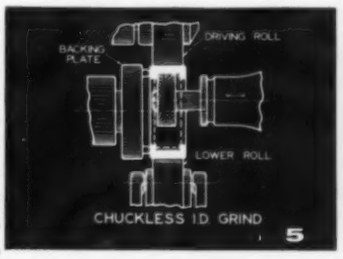
4. OPERATIONAL REQUIREMENTS

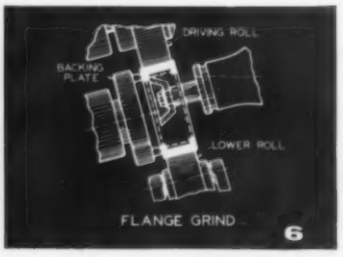
Quality controls are rigidly applied to all HYATT outer races to maintain: a. Minimum wall variation; b. minimum runout of race ends to bore; c. minimum runout of race flange inner faces to bore; d. minimum pathway and outer diameter taper; e. minimum outer diameter tolerance.

5. MANUFACTURING PROCEDURES

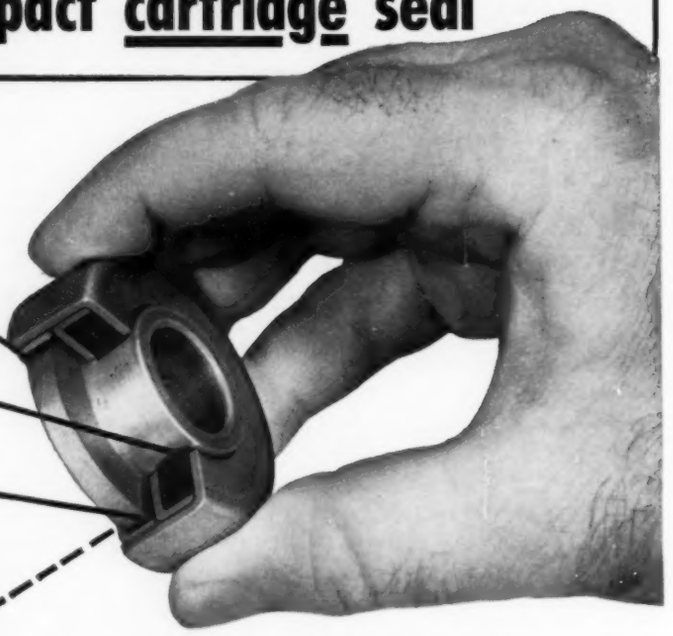


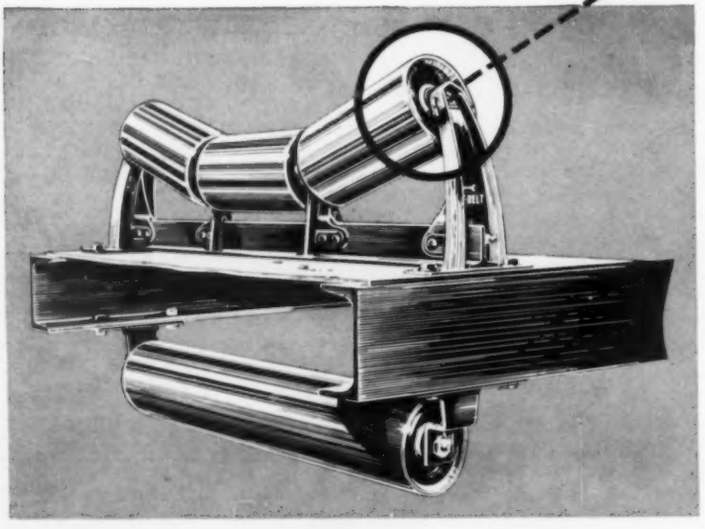
After careful primary machining and heat treating, ends are faced off square and parallel by a double end grind. This provides a reference surface from which all runouts and squareness can be gaged. Outer race diameters are generated by the centerless grinding method to provide an O.D. with as little out-of-round as practical. The through-feed method is a valuable economy (Figure 4). Next, the pathway (or race I.D.) is ground centerless, generating a cylinder concentric with the O.D. cylinder, by driving the race on the O.D. and positioning the grinding wheel relative to the drive roll (Figure 5). Finally, flanges are ground using the race ends as a reference. The result is a race of as nearly perfect geometry as is practical (Figure 6). Critical final inspection completes the procedures.





For longer idler life . . . here's 3-WAY protection in ONE simple, compact cartridge seal





THE effectiveness of Link-Belt cartridge grease seals in protecting belt conveyor idler bearings is matched by no other in industry. Besides the normal high efficiency of Link-Belt's labyrinth and contact seals . . . grease within the labyrinth further prevents entry of dirt or other particles. This cartridge (see above cutaway) is one integral unit—no springs, no loose washers . . . no possibility of metal-to-metal contact. From shaft to shell—bearings, fittings, rolls, frames, even hex nuts are designed for long, trouble-free life.

Also important, you can always find the *right* idler in industry's most comprehensive line—over 500 idlers in 34 types, built in a broad range of roll diameters and belt widths with matching return idlers. Ask your Link-Belt sales representative or authorized stock-carrying distributor for 48-page Book 2416, which covers this broad line thoroughly.

LINK-BELT

BELT CONVEYOR IDLERS

LINK-BELT'S superior grease seal is standard throughout industry's most comprehensive idler line

Series 100 Idlers
Continuous service for all but heaviest and coarsest materials.

Series 200 Idlers
Continuous service for heaviest and coarsest materials.

Series 400 Idlers
Continuous service for maximum volume per lineal foot of belt.

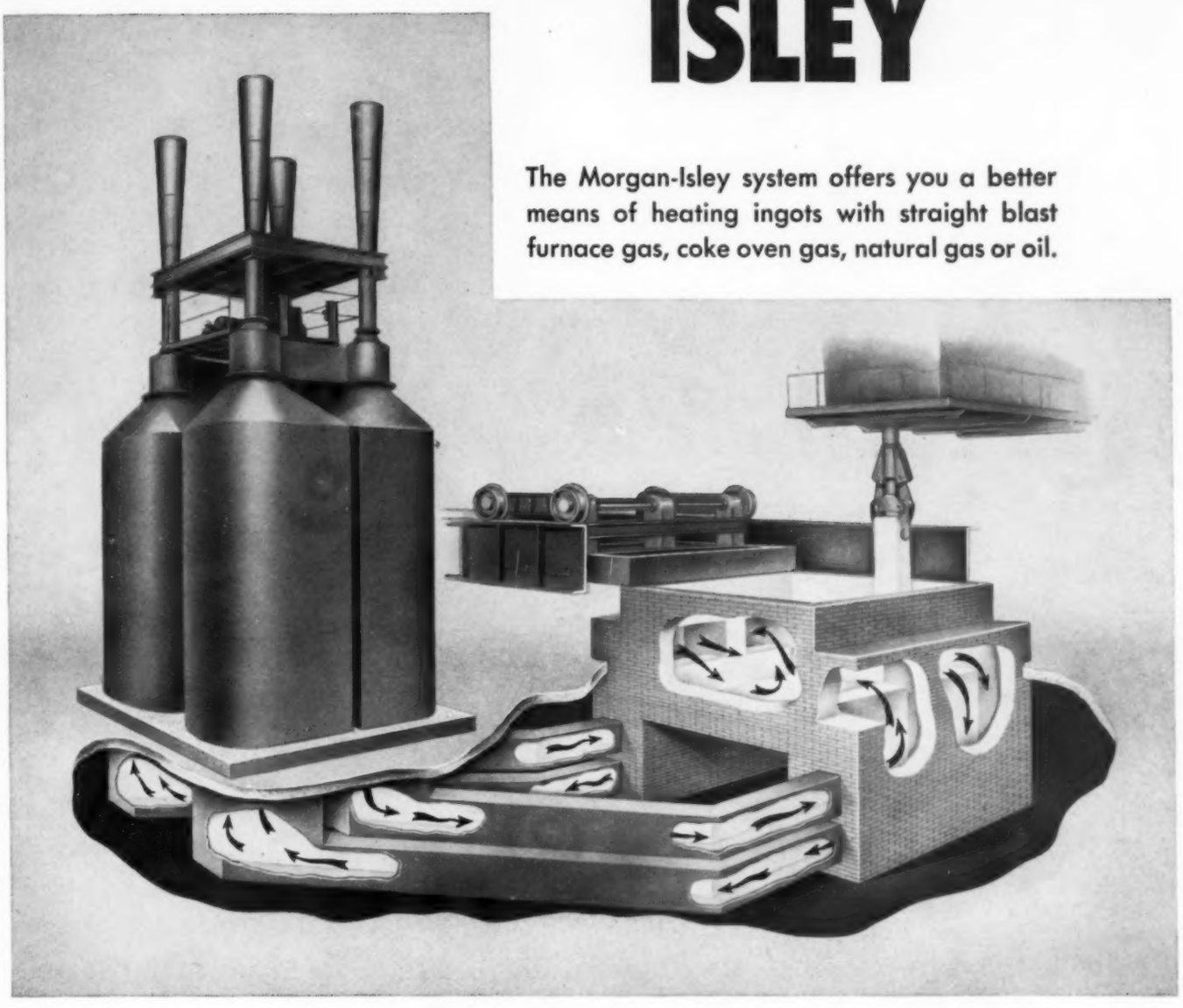
Series 500 Idlers
For greater volume than series 100 at maximum economy.

Series 600 Idlers
For grain and similar materials requiring only light belts.

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1, To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributor in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13,806

HEAT MORE STEEL with MORGAN-ISLEY

The Morgan-Isley system offers you a better means of heating ingots with straight blast furnace gas, coke oven gas, natural gas or oil.



The schematic shows the flow of combustion air and flue gases through the regenerators and soaking pit. The Morgan-Isley system employs vertical regenerators. It eliminates regenerator capacity under the crane runway thus freeing this valuable area for heating steel.

CCC-69

MORGAN CONSTRUCTION COMPANY WORCESTER, MASS.

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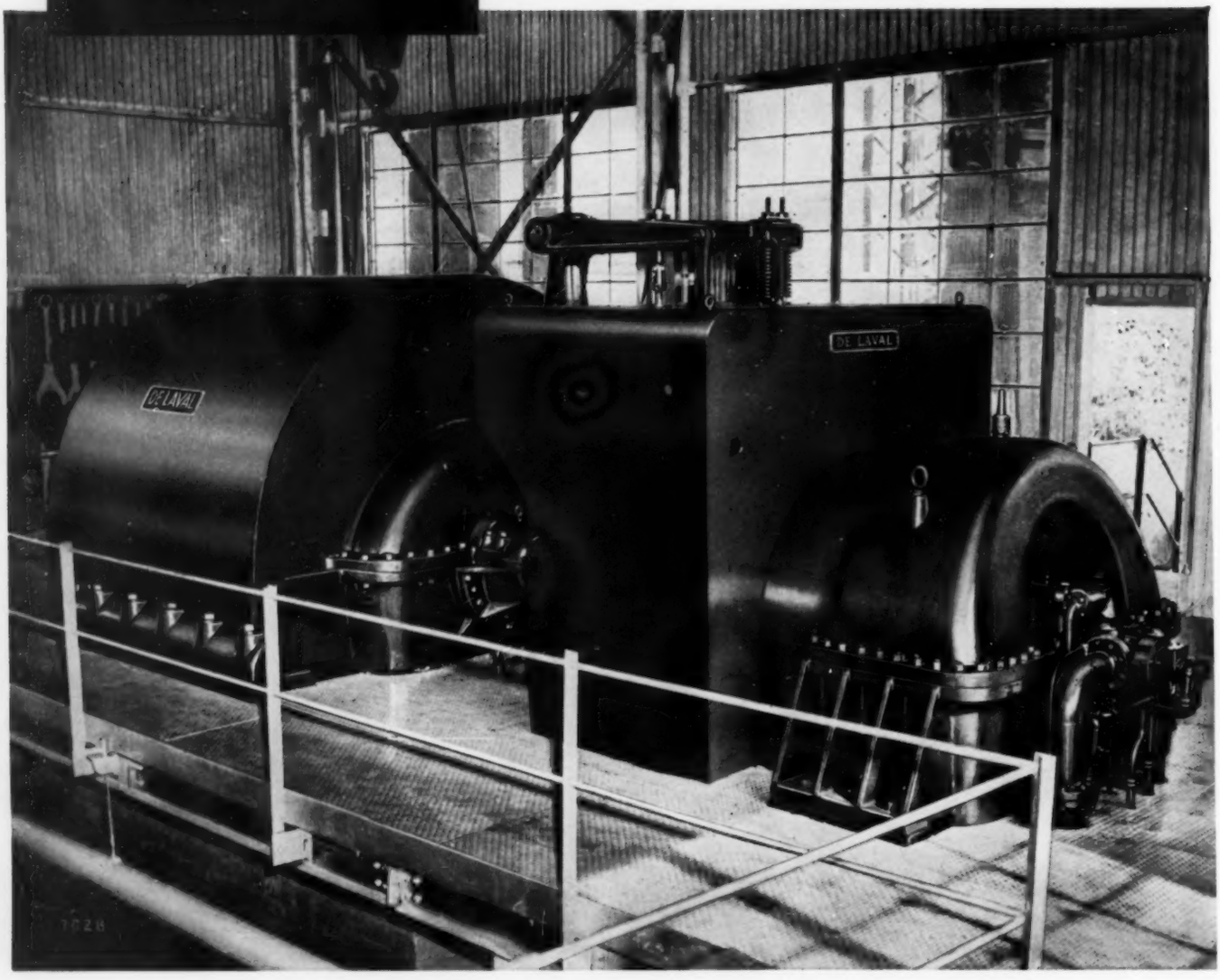
H. H. Wood, Rep., Koppers Bldg., Pittsburgh, Pa. *English Rep.*, International Construction Co., 56 Kingsway, London W. C. 2, Eng.

DE LAVAL CENTRIFUGAL BLOWER

delivers 75,000 cfm for southern steel mill



This De Laval 75,000 cfm blast furnace blower in a southern steel mill is driven by a 9,450 hp De Laval turbine operating at 2,900 rpm. Discharge pressure of the blower is 35 psig.

De Laval blowers have what it takes to give long service. The rugged casings and sturdy, perfectly balanced rotors are built to take punishment. The pressure lubricated sleeve bearings and Kingsbury type thrust bearing add durability and reduce maintenance. Both the turbine and blower are De Laval-designed and De Laval-made for top performance.

De Laval centrifugal blowers and compressors are built in single and multi-stage types to supply air in volumes up to 150,000 cfm for all classes of service in steel, gas and coke plants. The wealth of application experience acquired by De Laval over the years assures a correct and economical solution to your blower problem. Consult your De Laval Sales Engineer.

DE LAVAL *Centrifugal Blowers*

DE LAVAL STEAM TURBINE COMPANY

870 Nottingham Way, Trenton 2, New Jersey

DL 262

New spindle design for Farrel® HD grinder!
Result: *finer accuracy, reduced maintenance*

A number of improvements have recently been made in the Farrel heavy duty roll grinder and important among these is the new grinding wheel spindle design.

Of large diameter for its length—to assure rigidity under working load—the spindle is mounted in Farrel "Truaxial" bearings. These offer many benefits over previous designs for smooth, vibrationless operation, faster and better finishing, ease of adjustment, positive lubrication and economy of maintenance.

Split, self-aligning pillow blocks provide positive positioning of the spindle in its bearings. Adjustment of running clearance is accomplished through adjusting screws. Contracting pressure of the pillow block on the supporting points of the bearing creates the effect of five individual bearing shoes, with a self-energized, high-pressure wedge of oil entering each of the five bearing areas. A fresh supply of oil is introduced between each of the bearing areas under predetermined pressure to assure an adequate, unbroken film over the entire bearing surface.

Spindle end thrust is taken by hardened steel thrust collars at the pulley end of the spindle. Grinding wheels and drive pulleys are end-mounted, permitting change of wheels and V-belts without disturbing either spindles or bearings.

Write for full details of this and other features of the improved Farrel HD roll grinder.

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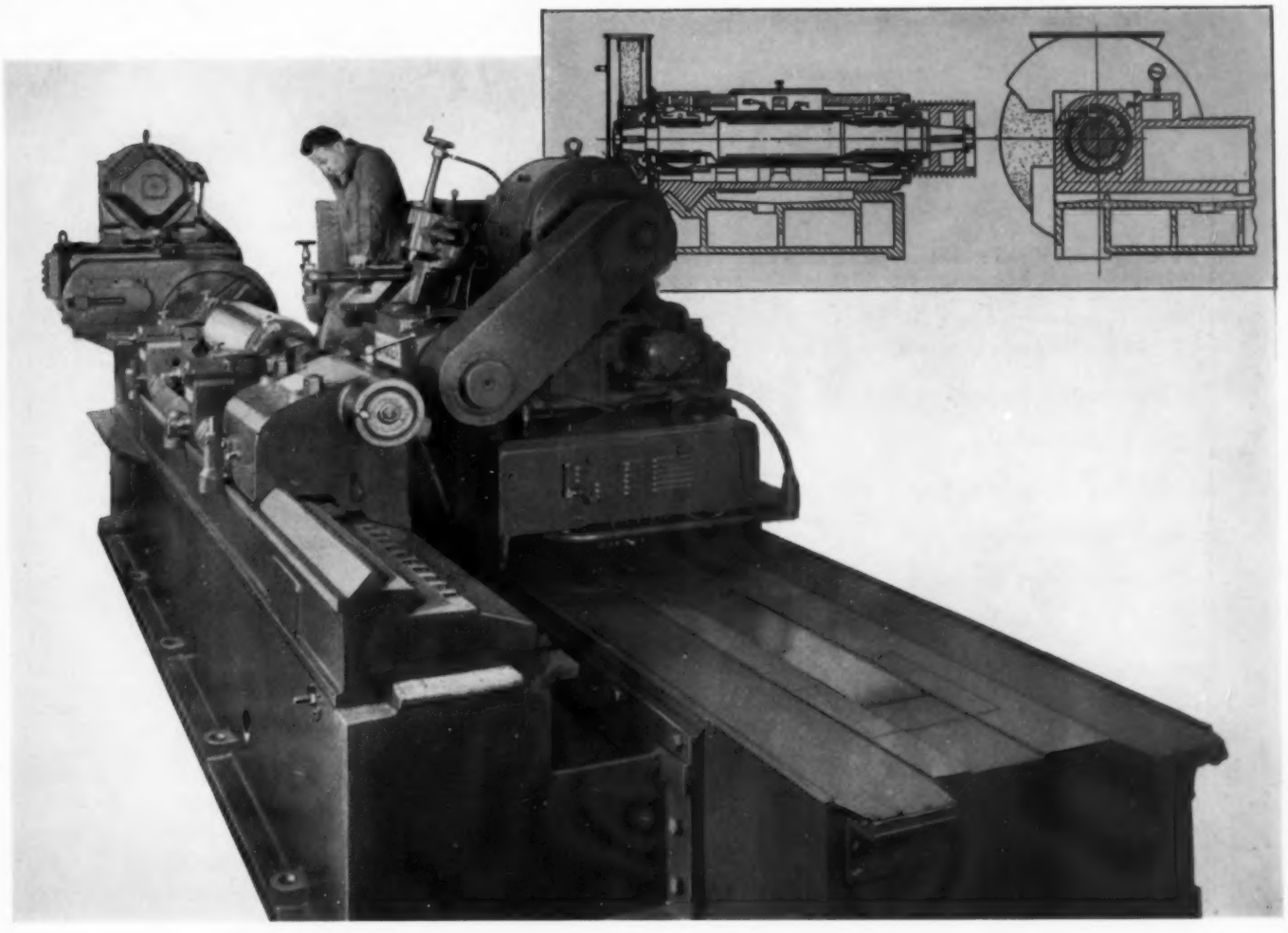
Plants: Ansonia and Derby, Conn., Buffalo and Rochester, N.Y. *Sales Offices:* Ansonia, Buffalo, New York, Akron, Chicago, Fayetteville (N. C.), Los Angeles, Houston



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Rolls • Rolling Mills • Slab, Rod and Strip Handling Equipment • Roller Tables • Rod Coilers • Slitters • Gears • Gear Drives of Any Capacity • Mill Pinions • Pinion Stands • Universal Mill Spindles • Flexible Couplings • Roll Grinding Machines • Roll Calipers • Hydraulic Presses for Extruding, Forming, Drawing, Forging, Trimming, Hobbing, Straightening and Bending.

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FB-1076

How Well Does Your Present Source Compare With National's COMPLETE Facilities For Motor and Generator Repair

Most motor repair shops can perform some of the operations listed below. Very few can handle them all. These are not routine operations, but extras which require expensive specialized equipment and experience. National service includes all 17 operations. How does your present repair source compare?

plus value operation	*available at National*	*at your present repair source*
1. redesigning and modernizing by competent engineers	yes	
2. vapor degreasing to insure good bonding of varnish	yes	
3. corncob blasting to prepare surfaces like new	yes	
4. rebuilding and remachining to standard of mechanical fits	yes	
5. temporary hotbanding to seat coils in slots	yes	
6. hot rerolling of permanent bands	yes	
7. grinding and polishing of journal shafts	yes	
8. vacuum impregnating	yes	
9. dynamic balancing	yes	
10. grinding and polishing of commutator at top operating speed	yes	
11. load testing	yes	
12. high frequency testing	yes	
13. electronic bar-to-bar and high sensitivity ductor testing	yes	
14. surge comparison testing	yes	
15. high potential ground testing	yes	
16. magniflux testing	yes	
17. anti-friction bearing inspection	yes	
Total	17	

If you can't answer "yes" for your present source on all 17 operations, you're taking unnecessary chances on getting less than the best repair work. You can't tell in advance on which jobs National equipment and National know-how will pay off in improved performance or longer life. So play it the one safe way — make National your first source for *all* motor and generator repairs.

For more details on why the motor or generator you send to National will often come back better than new, call your nearby National field engineer today. Or drop us a line for his name and address.

NATIONAL ELECTRIC COIL COMPANY

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ELECTRICAL ENGINEERS: MAKERS OF ELECTRICAL COILS AND INSULATION
REDESIGNING AND REPAIRING OF ROTATING ELECTRICAL MACHINES

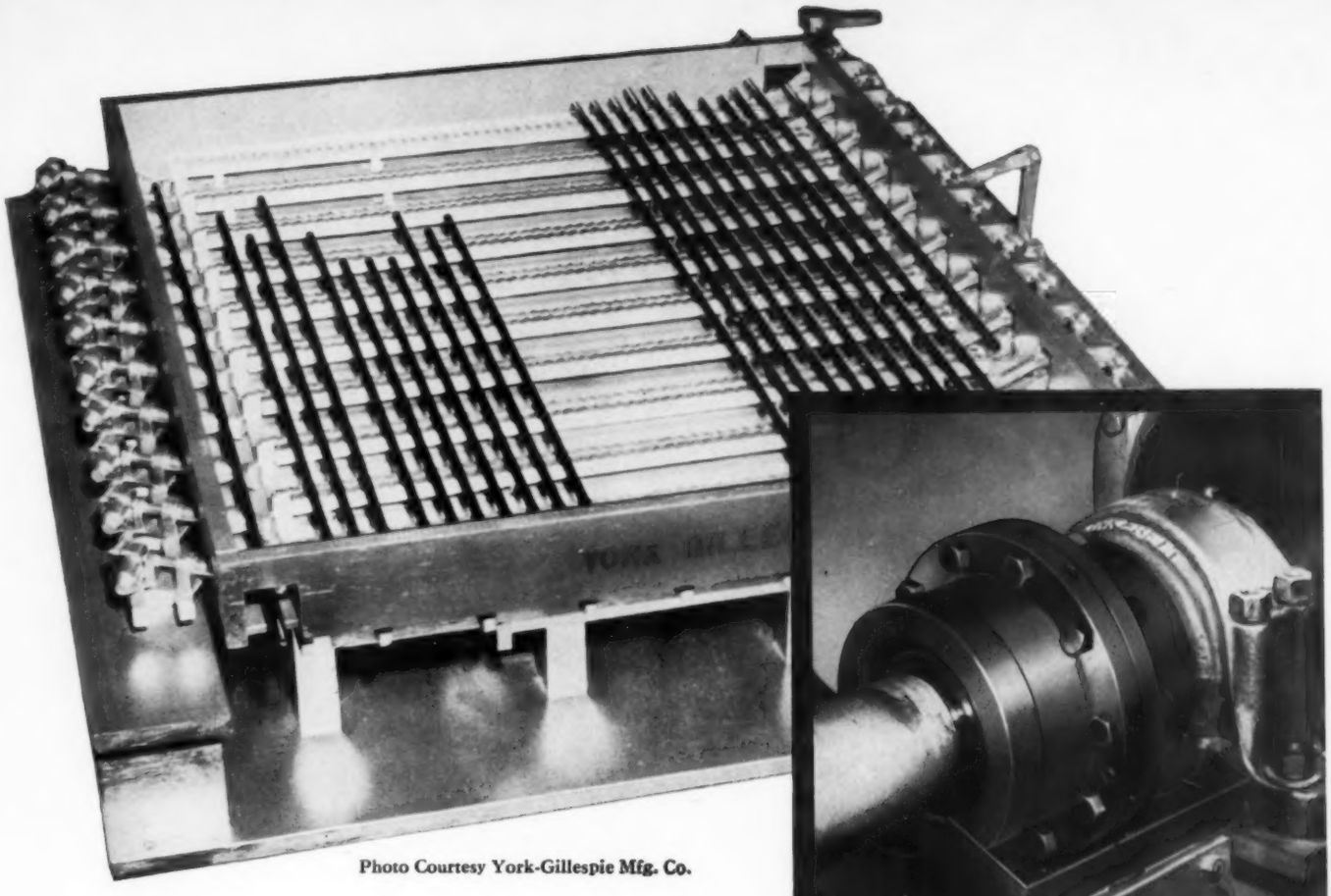

Photo Courtesy York-Gillespie Mfg. Co.

Photo Courtesy Jones & Laughlin Steel Corp.

Fast's Couplings help roll 30 tons of steel per hour through new Jones & Laughlin normalizing and quench tempering furnaces

At the Jones & Laughlin Aliquippa Works, Fast's Couplings are part of a new materials-handling process for transferring tubular steel products through the continuous normalizing and quench tempering furnaces. Pipe tubing is rotated automatically by a series of specially designed racks as it is transferred through the furnace. This design eliminates chill spots and minimizes warpage, insuring uniform heating at capacities up to 60,000 pounds per hour.

Fast's Couplings were used exclusively in this equipment . . . and for good reasons: They are subject to operation at extremely high temperatures that demand Fast's all-steel construction; torque transmission is high (low 3 RPM speed at eccentrics); Fast's Couplings offer mis-alignment protection for long-distance shafting—particularly important because of high temperatures and subsequent shaft growth; and Fast's Couplings are the best "shut down insurance" where continuous, trouble-free operation is essential.

This is another example of how Fast's Couplings fill specialized needs of industry with their famous Fast's construction and performance features. Koppers free engineering can assist you in selecting the right Fast's Coupling for your needs also. Mail the coupon below for a free catalog to: KOPPERS COMPANY, INC., Fast's Coupling Dept., 3005 Scott St., Baltimore 3, Maryland.

THE ORIGINAL *FAST'S Couplings*

KOPPERS

METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • BALTIMORE, MD. This Koppers Division also supplies industry with American Hammered Industrial Piston and Sealing Rings, Koppers Electrostatic Precipitators, Aeromaster Fans and Gas Apparatus. *Engineered* Products Sold with *Service*

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Gentlemen: Send me a Fast's Catalog giving detailed descriptions, engineering drawings, capacity tables and photographs.

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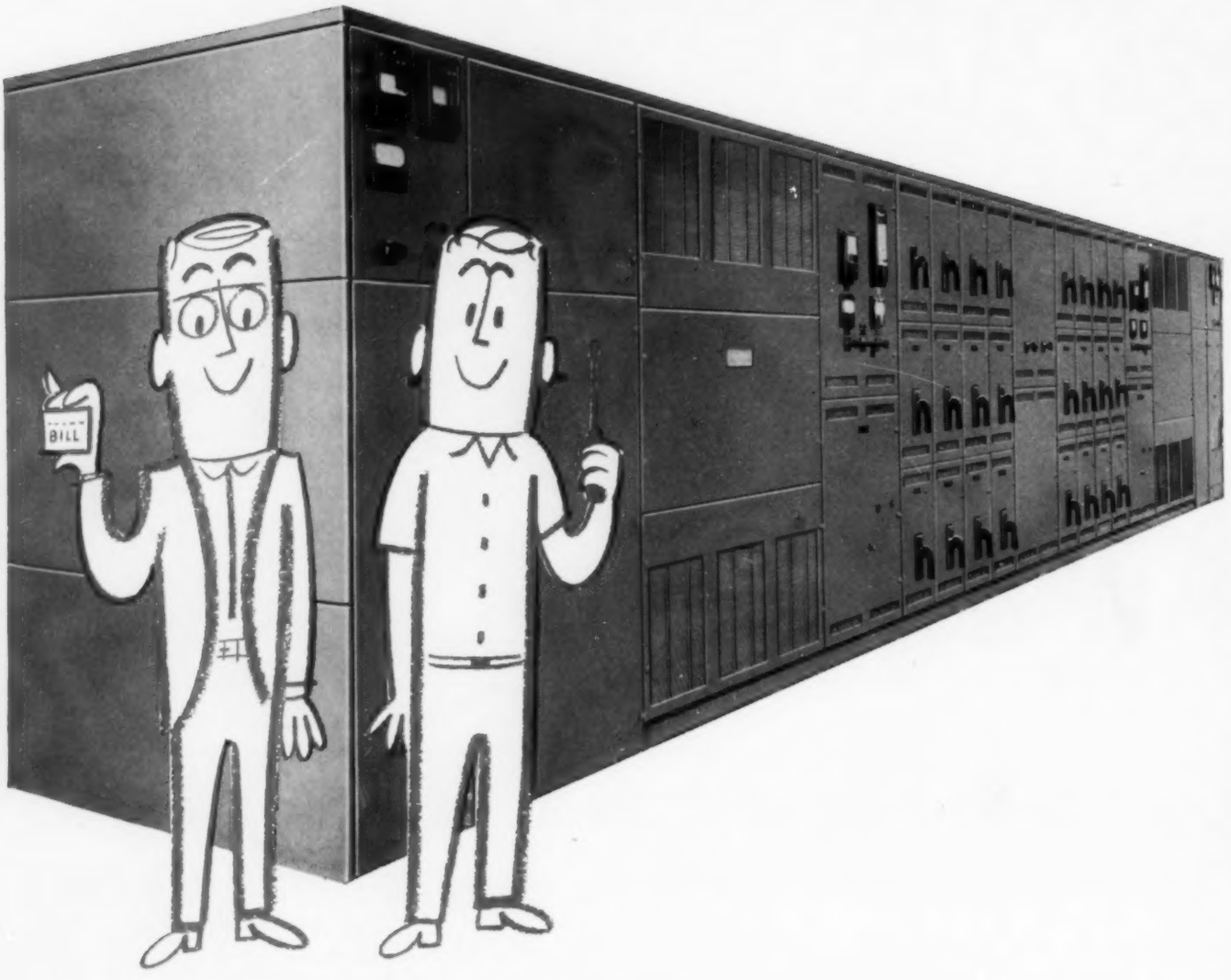
I-T-E Secondary Unit Substations



. . . designed and built for economy in installation and operation

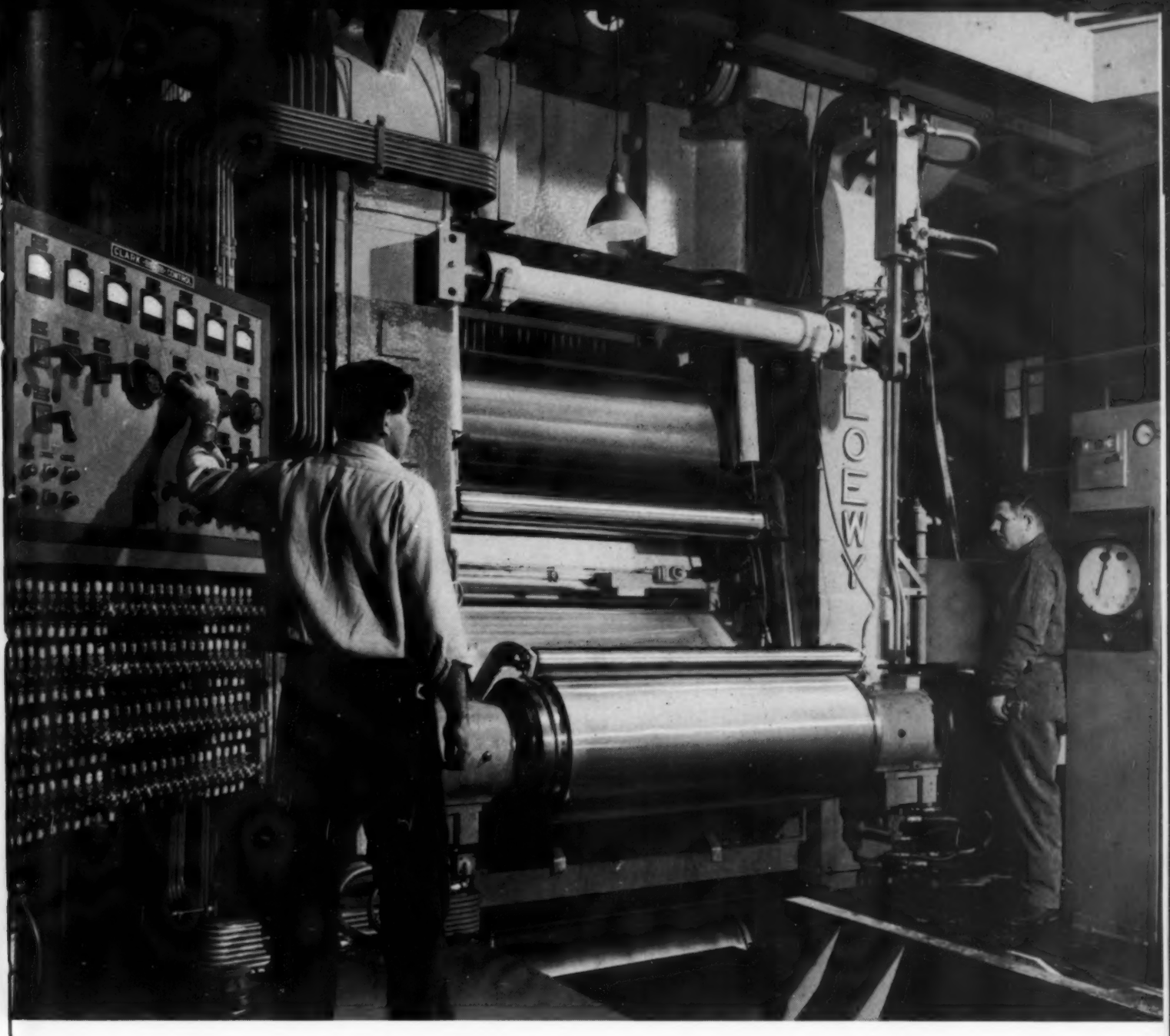
I-T-E Secondary Unit Substations bring electric power nearer to where you use it—make it more dependable—save you time and money.
They do it in several ways:

- By bringing higher voltages nearer the load and reducing power losses
- By reducing voltage drops inherent in long low-voltage runs and increasing machine efficiency
- By saving space—all necessary components are housed in one functionally designed unit
- By cutting delivery and installation time—units are assembled, tested and shipped ready for immediate installation from one source of supply
- By protecting plant personnel—all live parts are isolated and metal enclosed

I-T-E Secondary Unit Substations can be supplied for any application indoor or outdoor, and in any standard rating. For complete information, contact your nearest I-T-E sales office. Or write I-T-E Circuit Breaker Company, 19th & Hamilton Sts., Phila. 30, Pa.

I-T-E

I-T-E CIRCUIT BREAKER COMPANY • Switchgear Division



Loewy-Hydropress foil mill reduces aluminum from .026" to .00025" at speeds up to 3000 fpm

At Kaiser Aluminum and Chemical Corporation's Permanente plant, this Loewy four-high 60-inch mill is producing foil up to 54 inches wide. This is the widest aluminum foil made in the west.

The Loewy mill reduces aluminum from .026" to .00025" in thickness, at speeds up to 3,000 fpm. Its installation increased plant rated capacity 50%—from 12 million to 18 million pounds per year.

Loewy can furnish you with high speed foil mills up to 72" or wider, to meet your requirements. In addition, we design, build and install blooming mills, continuous billet, sheet, bar and skelp mills, continuous strip mills, high-speed cold rolling sheet and strip mills, continuous merchant and wire-rod mills, rail and structural mills, and special mills. For illustrated bulletin L-102-A, write Dept. 017, Loewy-Hydropress Division, BLH Corporation, 350 Fifth Avenue, New York 1, New York.

BALDWIN BLH LIMA-HAMILTON

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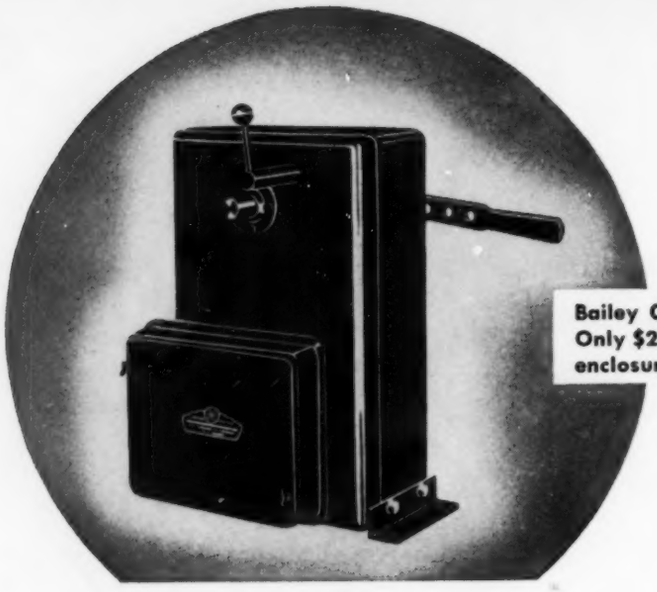
DIVISIONS: Austin-Western • Eddystone • Hamilton • Electronics & Instrumentation • Lima • Madsen • Loewy-Hydropress • Pelton • Standard Steel Works



Bailey Control Drive, Type AC44P Model 200. Only $210.00 F.O.B. Cleveland, complete with enclosure, positioning relay and hand operator.

Want Better Flow Characteristics from Your Regulating Devices?

This new, small, piston-operated Bailey Control Drive will improve the flow characteristics of butterfly valves, dampers, hydraulic couplings, feeders and similar regulating devices. Adjustment is simple; any desired relation between drive motion and pneumatic signal may be secured.

You can install this compact pneumatic drive power unit in any position on a column, pipe, or flat surface—and connect it to the regulating device with standard Bailey linkage, available from stock.

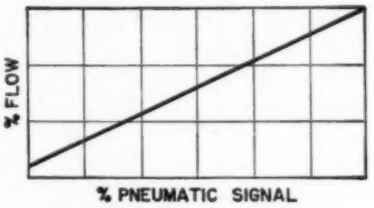
Speed (time required for full travel) is adjustable to suit your requirements. Bailey Control Drives operate on standard SAMA pneumatic signal ranges of 3 - 15 or 3 - 27 psig.

AVAILABLE FROM STOCK in 3 standard sizes

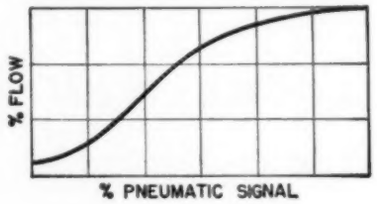
Type	Piston Dia. Inches	Piston Stroke Inches	Torque ft-lb	Max. Travel Degrees	Approx. Dimensions Inches
AC816	8	16	1500	90	13 x 27 x 51
AC68	6	8	400	90	13 x 19 x 34
AC44	4	4	75	75	10 x 11 x 19

P-28

The New Bailey Control Drive gives you THIS—



instead of THIS



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Progress Report On Blast Furnace Gas Cleaning

Since the development work was completed five years ago, seven Pease-Anthony Blast Furnace Gas Washers have been installed and are operating. Three more are under construction and many more are in the planning stage.

The following table summarizes the performance of the operating washers:

Installation	Years Operated	Volume SCF	Pressure Drop Inches Water	Dust Loading Grains/SCF Inlet	Outlet
A	4	78,000	30	3–19.0	.01–.04
B	3½	78,000	30	2–3	.02–.08
C	3	85,000	30–40	2–3	.01–.03
D	3	45,000	30	2	.02–.03
E	½	75,000	50	—	.02
F	½	26,000*	12	5	.10
G	½	26,000*	12	5	.10

Installation C is in Illinois. All others are in Pennsylvania.

*Two units in parallel on one furnace. Higher clean gas loadings due to lower available top pressure.

Users enthusiastically approve these modern washers. Typical comments from Chief Engineers, Blast Furnace Superintendents and Combustion Engineers are:

"The P-A Washer requires zero maintenance."
"No secondary cleaner required."
"Gives consistently good cleaning at all times."
"A *natural* where high top pressures are used."

For further information contact

Pease-Anthony Sales Department

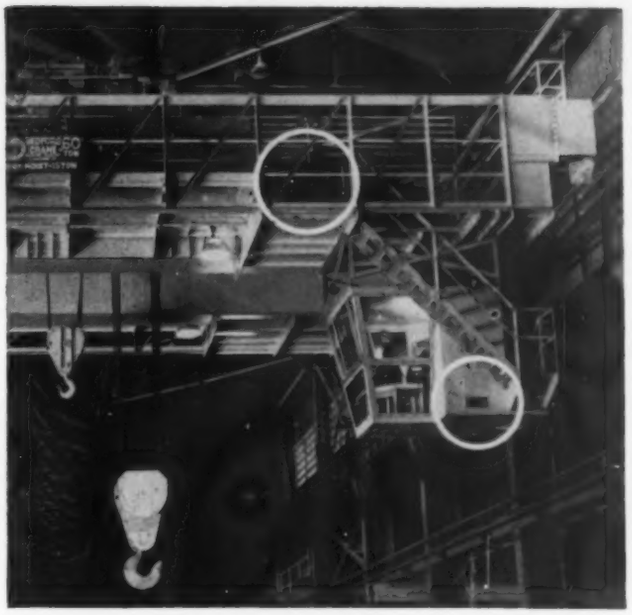
CHEMICAL CONSTRUCTION CORPORATION

525 WEST 43rd STREET, NEW YORK 36, NEW YORK

Telephone: LOngacre 4-9400

Technical Representatives Throughout the World

Cable Address: CHEMICONST, N. Y.



How LINTERN AIRE-RECTIFIERS Give Greater Value

MORE IN USE. Over 1000 Aire-Rectifiers are in daily use on practically every type of crane and pulpit operation in steel, aluminum, copper and other industrial plants, wherever excessive heat, dust, gas and fume conditions are prevalent.

MORE EXCLUSIVE FEATURES — assuring exceptional performance, long life, low maintenance. Space prohibits listing here. Ask us and we'll send you the list.

EASIEST TO INSTALL. The physical dimensions of Lintern Aire-Rectifiers are the smallest available, yet the capacity is greatest in comparable models.

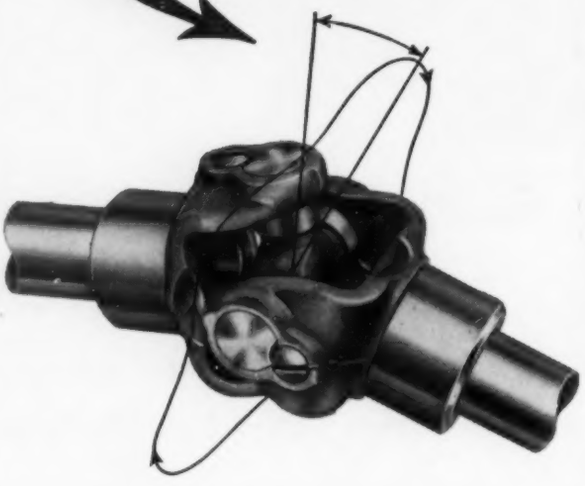
EASIEST TO SERVICE. All Aire-Rectifiers are so designed that the serviceman can service them in the least possible time. An important feature in providing dependable operation.

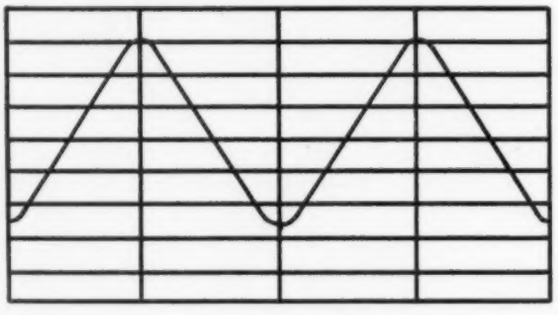
* * *

The quality built in is particularly appreciated in the years following installation as it is reflected in ample capacity and low maintenance requirements. For when all factors are considered, the initial price of Lintern Aire-Rectifiers represents utmost value. They actually repay their cost by their savings.

Larco, inc.
DISTRIBUTORS OF LINTERN CORPORATION PRODUCTS
ROUTE 20, EAST • PAINESVILLE, OHIO

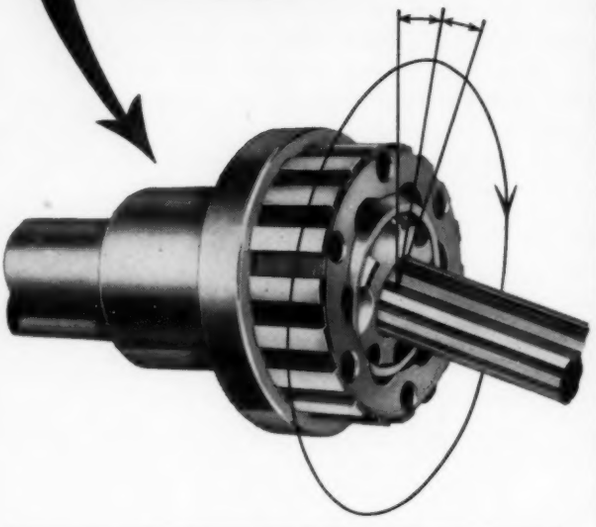
This Action Costs You Money

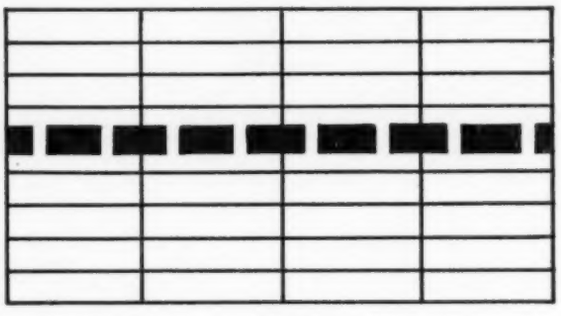




During rotation at a given angle, pin or slipper-type joints speed up, slow down twice during one revolution, as shown by the solid line in the graph.

This Action Saves You Money





Rzeppa Joints *always* transmit torque smoothly, even at unbalanced angles. Note constant velocity of 100% for Rzeppa Joint (dotted line).

Are You Getting The Most Out Of Your Rolling Equipment?

The simple illustration above shows how Rzeppa Constant Velocity Joints transmit torques smoothly —and profitably—on many of today's most advanced mills.

Steel-producing equipment of all types can take advantage of Rzeppa's unique design. It makes possible these money-saving features:

- INCREASED SPEEDS
- REDUCED DOWN-TIME
- LOWER MAINTENANCE
- GREATER ANGLES

Why not investigate? Write today for descriptive literature.

RZEPPA "SHEPPA"

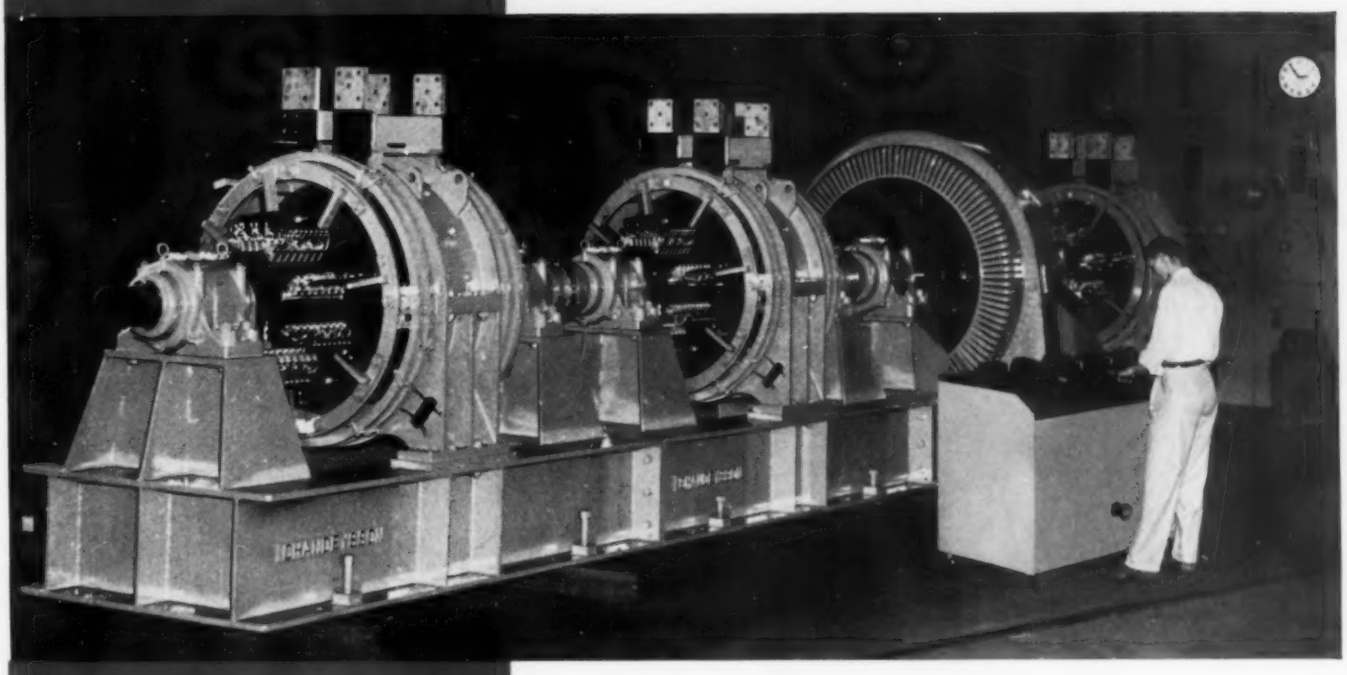
CONSTANT VELOCITY UNIVERSAL JOINTS

THE GEAR GRINDING MACHINE COMPANY

3929 Christopher, Detroit 11, Michigan

Manufacturers of: Fully Automatic Gear Grinding Machines • Detroit Screwmatic 750 single spindle screw machine.

IT HAPPENS AFTER MIDNIGHT...



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are tested relentlessly to assure you a top-efficiency, low-voltage power supply

Before leaving our plant, each Chandeysson generator is run for at least 12 hours at 110% of voltage and 115% of current . . . simultaneously. Performance data is scrutinized by skilled engineers using the most modern electrical testing equipment.

Testing such as this is one reason for the remarkable dependability and high efficiency of Chandeysson equipment. In addition, unified responsibility for the manufacture of every component . . . from selected raw materials to the finished product . . . is in the hands of skilled men who have decades of experience in building low-voltage generators. Our aim in engineering is to *prevent* design defects . . . rather than to correct for them. This is why more and more "Steel Industry Leaders Choose Chandeysson!"

MAKE US PROVE to you that a Chandeysson Motor Generator set is your most economical and dependable source of low-voltage dc . . . for tinning or any other electrolytic purpose. Mail this coupon today . . .

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4076 Bingham Avenue, St. Louis 16, Mo.

Please send steel mill bulletin.

Name..... Title.....

Company.....

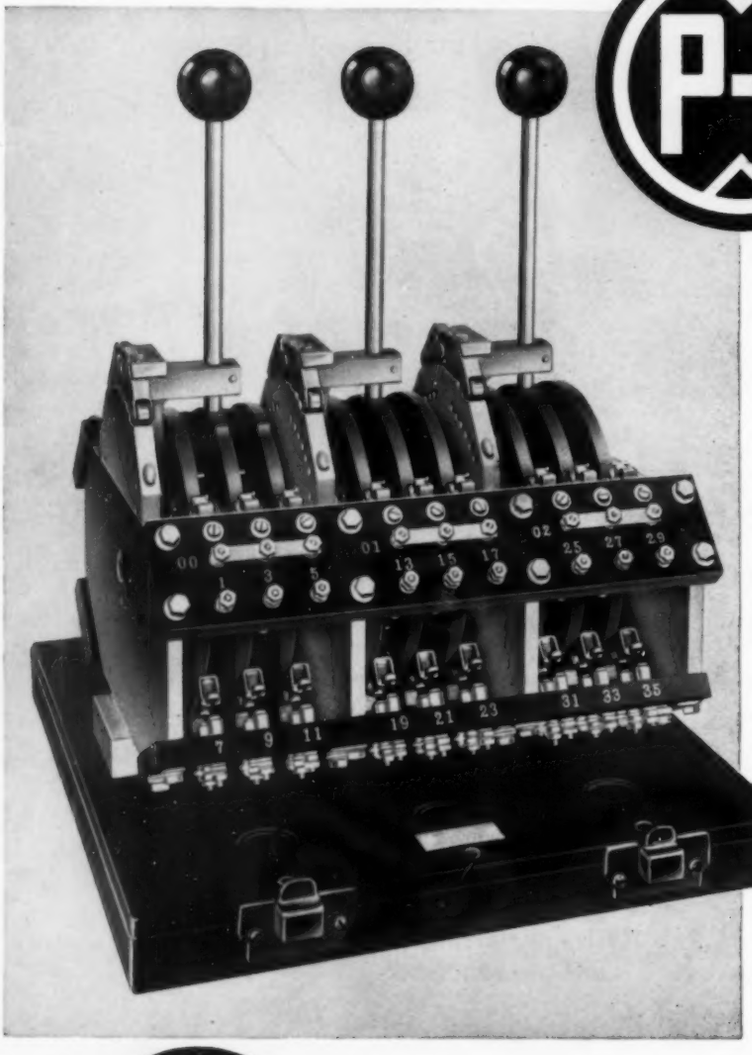
Address.....

City..... Zone..... State.....

CHANDEYSSON ELECTRIC COMPANY 4078 Bingham Avenue, St. Louis 16, Missouri

CHA-78R

Type MD
FOR GENERAL APPLICATION IN MILL SERVICE



P-G master switches

Unique in design, the Post-Glover Type MD Master Switch saves valuable mounting space in crowded crane cabs or mill pulpits where sufficient room has always been a problem. Up to four single masters can now be furnished in one enclosure on a single base, thereby simplifying installation of the switch.

Each single master has a maximum of 12 circuits and up to 6 points either direction. The operating lever has exceptionally short angular travel and can easily be adjusted in length, thus adding to operator comfort and efficiency.

Write for Bulletin 410

THE POST-GLOVER ELECTRIC COMPANY
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Publication Service...

MAY, 1956

You Can Obtain . . .

. . . any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.

Note: Post cards expire three months after publication date.

(1) Tubular Stress Data Card

A technical data folder published by the Tubular Products Division of The Babcock and Wilcox Co., gives the maximum allowable stress values for ferrous pipe and tubing. The folder contains the values at various temperatures for a complete range of seamless and welded carbon, alloy and stainless tubing steels. Also included in the folder are the formulae to be used in connection with the stress value in calculating the maximum allowable working pressures. (TDC-154A)

(2) Couplings

Dihedral spindle shaft couplings are described in a bulletin recently issued by Ajax Flexible Coupling Co., Inc. Cutaway views of these couplings are included as well as pictures of mills equipped with dihedral spindle shaft couplings. In addition, there is a discussion on the lubricating of these couplings. (Bulletin 58)

(3) Marking Machines

Jas. H. Matthews & Co., Inc., has issued a brochure on their No. 201 rotary table marking machine. The brochure illustrates the construction methods for special applications. Also included are the specifications for this marking machine and its principle of operation.

(4) Electrostatic Spray Painting

Released by Ransburg Electro-Coating Corp., is a new booklet on electrostatic spray painting. The booklet explains the company's No. 2 process of spray painting, and illustrates the disk atomizer and bell-shaped atomizer in explaining this process. Production line examples show a variety of applications of the No. 2 process in the finishing of industrial products. Triple head units, stationary disk, and reciprocating atomizing disk units are pictured.

(5) Testing Instruments

Available from the General Electric Co., is a testing instruments reference book. Eighty different devices are covered in this booklet which also contains complete product information including applications, sources of additional information and pictures. Instruments for research, production, laboratories, etc., are included. (GEC-1016)

(6) Bearings

Published by Chain Belt Co., Shafer Bearing Division, is a catalog on self-aligning roller bearings. The new booklet contains specification and data pages on these bearings. In addition the principle of concave rollers running between convex raceway is discussed. Included in the catalog is engineering data, new load rating tables, exploded view for parts identification, etc. (Catalog 55)

(7) Mounted Wheels

Principles of safe and efficient operation of mounted wheels and tables of maximum operating speeds are given in a 36-page booklet issued by the Grinding Wheel Institute. The eight easy-to-use maximum speed tables contained in this booklet are designed to facilitate users correct application. The booklet contains information on standard sizes of mounted wheels together with standard mandrel sizes applicable for each. There are three pages of silhouette drawings of the popular standard sizes of mounted wheels.

(8) Molybdenum Carbides and Nitrides

The physical, chemical and mechanical properties, and the preparation of molybdenum carbides and nitrides are summarized in a six-page bulletin released by Climax Molybdenum Co. The bulletin entitled, "Refractory Molybdenum Carbides and Nitrides" covers two molybdenum carbides, Mo_2C and MoC, and the two molybdenum nitrides, Mo_2N and MoN. (Bulletin Cdb-7)

(9) Welding Data Book

Available from Eutectic Welding Alloys Corp., is a 140-page pocket data book featuring simplified welding procedures for base metals. The book covers 120 welding rods, electrodes and welding compounds. The pocket-size data book is a guide to improved torch and metallic arc welding, brazing and soldering, and contains information on fabrication, maintenance repair and salvage, overlaying for wear and corrosion resistance and welding of dirty, rusted parts. Methods of gouging, chamfering and removing of unwanted metal without special equipment is also given. Special welding applications such as joints with high electrical conductivity, resistance to chemicals, tinning and plating are covered. (TIS 2575)

(10) Battery Chargers

The latest features of automatic battery chargers are illustrated in a four-page bulletin released by The Electric Products Co. The bulletin lists the advantages of these battery chargers, and illustrates a new type of battery line contactor, pointing out its synchronous motor time clock, battery line fuse, and flexible rubber-covered charging cable. (Bulletin 11-210)

(11) Loop Control

A bulletin describing the operation of the magnetic loop control for steel mill pickling lines has been released by the General Electric Co. The bulletin also includes a typical list of equipment required for magnetic loop control, and the advantages of this system. (GEA-6486)

(12) Industrial Filters

Released by the R. P. Adams Co., Inc., is a bulletin featuring their new line of industrial filters. Data on the filters includes sectional views in three colors, typical installation drawings, dimension charts and four color operational diagrams. Also included are three color sectional illustrations of their automatic filters. (Bulletin 651)

(13) Heating Units

Published by Selas Corp. of America is an eight-page bulletin describing their gas-fired heating units known as ribbon burners. The bulletin contains such information as heating techniques, ribbon burner capacities, and selection data for these gas-fired units that produce a narrow, uniform sheet or "ribbon" of flame. (Bulletin SC-1004)

(14) Wire Rope

Issued by the American Cable Division, American Chain and Cable Co., Inc., is a booklet covering the different types of wire ropes used in industry. Such points as rope diameters, construction, preforming, lay, grade and core are discussed in this booklet. In addition, charts covering weights and breaking strengths are provided as are photographs and drawings of typical wire rope riggings and accessories. (Bulletin DH-128D)

(15) Switches

A complete line of single-pole, outdoor, hook operated disconnecting switches is described in a six page bulletin released by Delta-Star Electric Division, H. K. Porter Co., Inc. Fully illustrated, the bulletin explains the switch design, construction, and operation. Types for upright, vertical, and inverted mounting, with ratings from 7.2 to 115 kv; 400, 600 and 1200 amp are listed. Complete tables give catalog numbers, nominal ratings, and dimensions as well as maximum design voltage, impulse withstand voltage, and momentary current ratings.

(16) Heat Treating Ductile Iron

A pamphlet outlining the commercial processes for developing in ductile iron castings tensile strength from 60,000 to 150,000 psi and elongation as high as 25 per cent has been released by the International Nickel Co., Inc. This booklet recommends suitable heat treatments for specific industrial applications, and includes graphs and tables.

(17) Combustion Meters

A four-page catalog that describes the different types of chemically operated CO_2 analyzers and recorders has been released by the Hays Corp. The folder contains photos of these instruments as well as descriptions of their operation and sampling system. Also included are applications, principles, features, available models and standard chart of these combustion meters. (Catalog 56-553-1)

(18) Regulator

A four-page bulletin that describes the applicability, operation and features of a regulator which develops a powerful correcting action in reponse to a wide range of control signals is available from Askania Regulator Co. The bulletin describes features of operation for the unit when used for such applications as relief and reducing valve operations, liquid level, feed water pumps, steam pressure reducing stations for pressure control, flow control, and anti-surge governor for blower installations. (Bulletin No. 165)

(19) Grouting Guide

A guide that clearly illustrates 11 common machinery settings, methods of grouting and forming, and hot and cold weather grouting has been published by the Master Builders Co. The booklet discusses proper mixing and placing of grout, reasons for using prepared, non-shrink grout, etc.

(20) Dust Recovery Equipment

The theories and basic principles of centrifugal dust recovery are outlined in a 32-page booklet released by Western Precipitation Corp. This booklet not only explains the basic methods involved in centrifugal dust recovery, but also shows the important differences between small and large diameter separating tubes, shows how to simplify your duct work and reduce installation costs, and outlines many other important factors to be considered in selecting mechanical dust recovery equipment.

(21) Instruments

Available from the Bristol Co., is a booklet describing their electronic potentiometer and bridge instruments for recording and controlling. Divided into three main sections, the first section gives details of the instrument and its components, as well as the principles of operation. Full specifications are listed for the various models of recorders, and automatic controllers available. The second section lists sensing elements and special attachments, such as resistance bulbs, magnetos, photocells, conductivity cells, and frequency converters, plus computing, telemetering, totalizing, and digital read out attachments. The third section describes and illustrates strain gages, viscosity meters, thickness gages, and gas analyzers. (P1245A)

(22) Insulations and Refractories

Thermal insulations and refractories for general industrial applications is the subject of a new 20-page catalog published by Johns-Manville Corp. This factual catalog organized for quick reference, provides information on the composition, physical and thermal properties and sizes of the various products. It lists outstanding benefits which the products provide both at the time of installation and in service. The booklet also covers materials for the efficient control of temperatures from 400 F below zero to 3000 F above.

(23) Equipment

Pennsylvania Engineering Corp., has published a catalog detailing its facilities and products. The brochure illustrates the company's custom tailored steel products such as blast furnaces, cars, converters, ladles and oxygen vessels, together with a listing of installations in this country and abroad.

(24) Control and Transfer Switches

Available from General Electric Co., is a new bulletin describing their complete line of control and transfer switches for low voltage applications up to 600 volts a-c or d-c. Included is a description of switches with water-tight and explosion-proof housings, as well as photos, drawings and cutaways. Application data, representative contact diagrams and ordering directions are also contained in the bulletin. (GEA-4746B)

(25) Single-Stage Pump

A new pump bulletin covering a re-designed line of DMV-DHV single-stage centrifugal pumps is now available from Ingersoll-Rand. Incorporated in this bulletin are typical installation views, cross sectional views and an exploded view of component parts and dimensions. An interchangeability chart is also illustrated to show the maximum interchangeability of parts throughout the entire line. (Form 7248-A)

(26) Thermocouple Circuit Restorer

The Thermocouple Circuit "Restorer," a device for renewing proper electrical conductivity through thermocouples and thermocouple circuits used in heat-treating, melting and other processing operations, is covered in a catalog released by the Peerless Electric Co. Diagrams, installation photos and recorder chart reproductions illustrate how the restorer monitors couples and thermocouple circuits transmitting EMF to temperature indicators, recorders and controllers. (Catalog R-26)

(27) Converting Acid Furnaces to Basic

Basic Inc. announces the availability of its new booklet entitled "Let's Make Basic Steel." This booklet, in addition to discussing the comparative merits of both acid furnaces and basic, outlines advantages of basic operation, estimates probable conversion costs and explains certain operating difficulties and their corrective measures. (B-103)

(28) Snap Hearth Furnace

A new snap hearth furnace which has been added to the Surface Combustion Corp.'s line of standard furnaces is described in a folder made available by the company. The folder shows diagrams, curves and application pictures. (Bulletin SC-173)

(29) Batteries

The new line of Exide-Manchex batteries which features increased life and higher instantaneous discharge rates is illustrated and described in a new catalog just published by Exide Industrial Division, The Electric Storage Battery Co. A cutaway drawing shows details of construction, including the heat-resistant polystyrene jar, the support ledges molded into the jar walls from which the battery elements are suspended, and the molded one-piece polystyrene dowels. Other illustrations show Exide's Plante positive plate, consisting of a cast lead antimony grid into which rosettes or buttons of pure lead are permanently locked, the negative plate which holds the active material securely in place and the microporous rubber separators which, with the plastic dowels, insulate the positive from the negative plates.

(30) Multiple Tools

A new book of prints detailing the construction of 50 special multidiam tools has been published by O.K. Tool Co., Inc. Drawings show various types of boring heads, form cutters, milling cutters, end mills, reamers, trepanning tools, all designed to perform three, four and more operations with one pass. All industries are represented, all manner of work-pieces — tool bases, cam shafts, aircraft engines, frames, landing gear; valve bodies, track saddles, filter heads, pump housings. Tools are equipped with various kinds of blades — high speed steel, cobalt, vasco supreme and carbide, restricted only by the amount of hp available.

(31) Switches

Delta-Star Electric Division, H. K. Porter Co., Inc. announces the availability of a technical publication, which covers a newly designed line of PMB-40 horizontal single side break, braidless, group operated switches. Tables provide all the technical data as well as complete weights and dimensions. Switches rated from 7.2 to 161 kv in current ratings of 400, 600 and 1200 amperes are listed. (5604)

(32) Variable Speed Drive

A booklet carrying multi-color tables for quick and easy selection of variable speed "Texrope" drives has been released by Allis-Chalmers Manufacturing Co. In addition, the booklet includes information on design features, drive principles, hp rating tables for A, B, C, D, and E section belts, a speed range table showing the variation in rpm when using two "Vari-Pitch" sheaves in combination, and accessory equipment for the "Vari-Pitch" drive. (20P50)

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PUBLICATIONS CURRENTLY OFFERED by Iron and Steel Engineer Advertisers

ITEM	COMPANY	BULLETIN	DESCRIPTION
50	ASKANIA REGULATOR CO.	BULLETIN 301	Transometers.
51	BAILEY CO., WILLIAM M.		Clay guns.
52	BAILEY METER CO.	SPEC. CA040 & SPEC. CA942B	Control drives and control linkage.
53	BLISS CO., E. W.	CATALOG 40-A	Rolling mills.
54	BUSSMANN MFG. CO.	BULLETIN HCS & FIS	Dual-element fuses and hi-cap fuses.
55	CHANDEYSSON ELECTRIC CO.		Steel mill bulletin.
56	CLARK CONTROLLER CO.	BULLETIN PL-7305	Relays.
57	DELTA-STAR ELECTRIC DIVISION, H. K. PORTER CO., INC.	BULLETIN 5005	Conductor rail supports.
58	DODGE MANUFACTURING CORP.		Speed reducer.
59	DURALOY CO., THE	BULLETIN 3354-G	High alloy castings.
60	ELECTRIC CONTROLLER AND MANUFACTURING CO.	BULLETIN 900-L	All-welded magnets.
61	ELECTRIC CONTROLLER AND MANUFACTURING CO.	BULLETIN 921-2926	Controllers.
62	ELECTRIC MACHINERY MFG. CO.	E-M SYNCHRONIZER NO. 32	Air compressor drive applications.
63	ELECTRIC SERVICE MANUFACTURING CO.		Aluminum conductor system installations.
64	GEAR GRINDING MACHINE CO., THE		Rolling equipment.
65	GENERAL ELECTRIC CO.	BULLETIN GEA-6236	Tap-changers.
66	HARNISCHFEGER CORP.		Overhead cranes.
67	HUNT AND SON., INC., C. B.	BULLETIN NO. 531	Hydraulic valves.
68	HYATT BEARINGS DIVISION, GENERAL MOTORS CORP.	CATALOG NO. 150	Cylindrical roller bearings.
69	I-T-E CIRCUIT BREAKER CO.	BULLETIN 6004B	Circuit breakers.
70	KOPPERS CO., INC., FAST'S COUPLING DEPT.		Couplings.
71	KOPPERS CO., INC., FREYN DEPT.		Recorders.
72	LECTROMELT FURNACE CO., DIVISION, McGRAW ELECTRIC CO.	CATALOG 9-A	Types of melting and refining furnaces.
73	LINK-BELT CO.	BOOK 2447	Gear motors.
74	LOEWY-HYDROPRESS DIVISION, BALDWIN-LIMA-HAMILTON CORP.	BULLETIN L-102-A	Mills.
75	LUBRIPLATE DIVISION, FISKE BROTHERS REFINING CO.		Lubrication.
76	MANSAVER INDUSTRIES, INC.		Grabs for handling coils.
77	MINNEAPOLIS-HONEYWELL REGULATOR CO.	CATALOG 1521 AND CATALOG 1531	Electronic recorders and controllers.
78	MORGARDSHAMMARS	BULLETIN L3-1E	Roller guides in bar or wire rod mills.
79	NATIONAL CARBON CO., DIVISION UNION CARBIDE AND CARBON CORP.	CATALOG SECTION B-0635	Mill-motor brushes.
80	NORTH AMERICAN MFG. CO.	BULLETIN 214	Burners.
81	OHIO ELECTRIC MFG. CO., THE	BULLETIN 112	Magnets.
82	PANGBORN CORP.	BULLETIN 227	Blast cleaning machines.
83	PARKER APPLIANCE CO., THE	BULLETIN 4402	Straight-thread fittings.
84	PENNSYLVANIA ENGINEERING CORP.		Engineering equipment.
85	POST-GLOVER ELECTRIC CO.	BULLETIN 410	Switches.
86	RELIANCE ELECTRIC AND ENGINEERING CO.	BULLETIN A-1555-B	Automation.
87	RUST-OLEUM CORP.		Report on penetration of rust to bare metal.
88	SPRAYING SYSTEMS CO.	DATA SHEET 6120	Descaling nozzles.
89	SUN OIL CO.	BULLETIN 32	Extreme-pressure lubricants.
90	TAYLOR CHAIN CO., S. G.	BULLETIN NO. 90	Alloy steel hooks.
91	TAYLOR INSTRUMENT COS.	BULLETIN NO. 98262	Potentiometer transmitter.
92	TREADWELL CO., INC., M. H.	BULLETIN NO. 60	Hot metal cars.
93	UNITED STATES GRAPHITE CO.		Brushes.
94	WAGNER ELECTRIC CORP.		Industrial motors.
95	WHEELABRATOR CORP.	BULLETIN NO. 864	Mechanical descaling process.

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IRON & STEEL ENGINEER

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BUSINESS REPLY CARD

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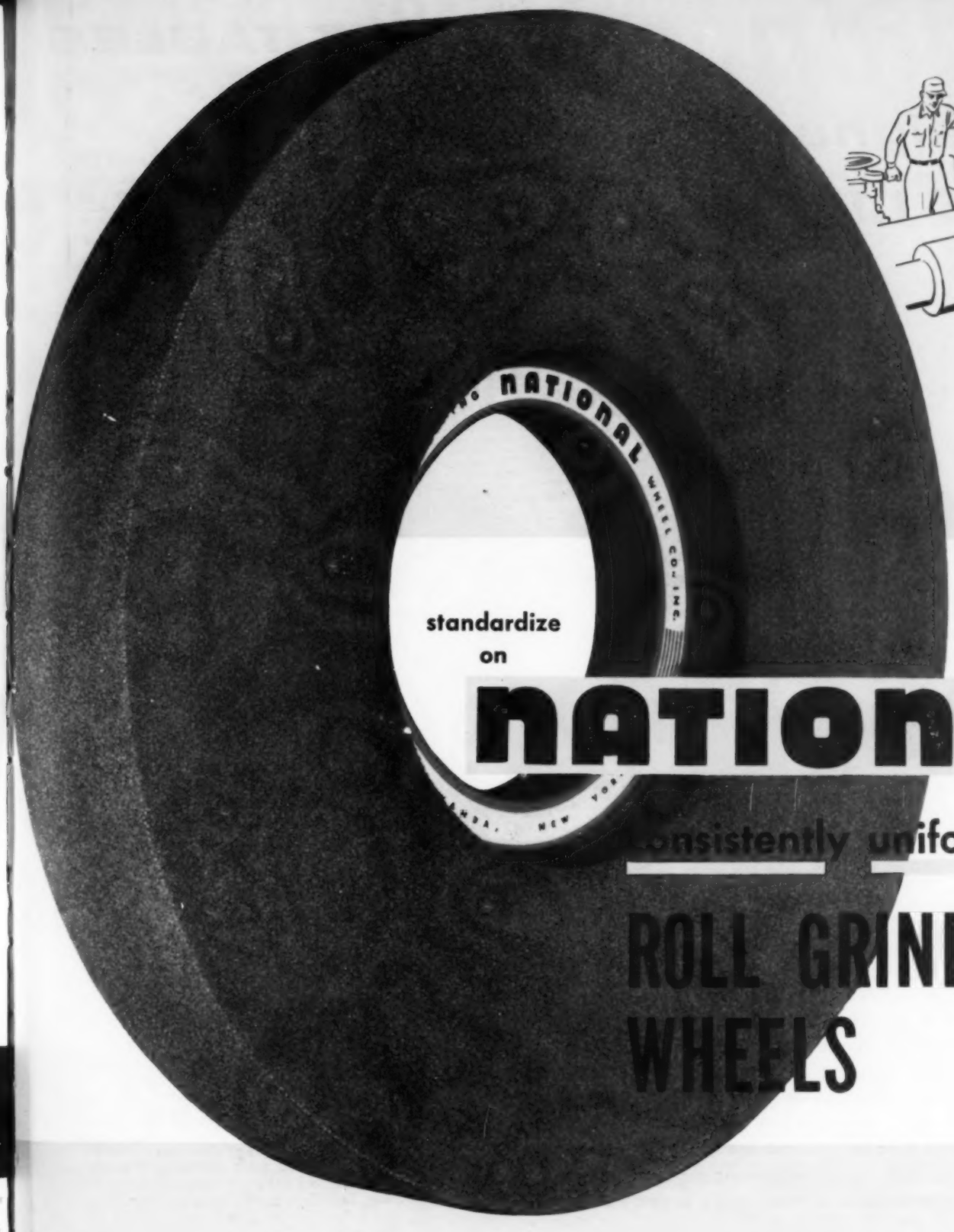
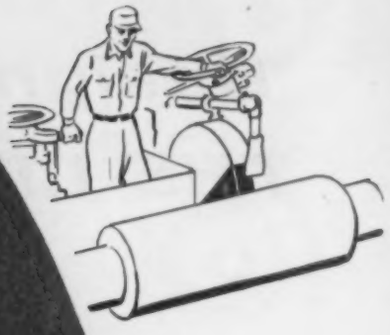
IRON & STEEL ENGINEER

1011 EMPIRE BUILDING

PITTSBURGH 22, PA.





standardize
on

NATIONAL

consistently uniform

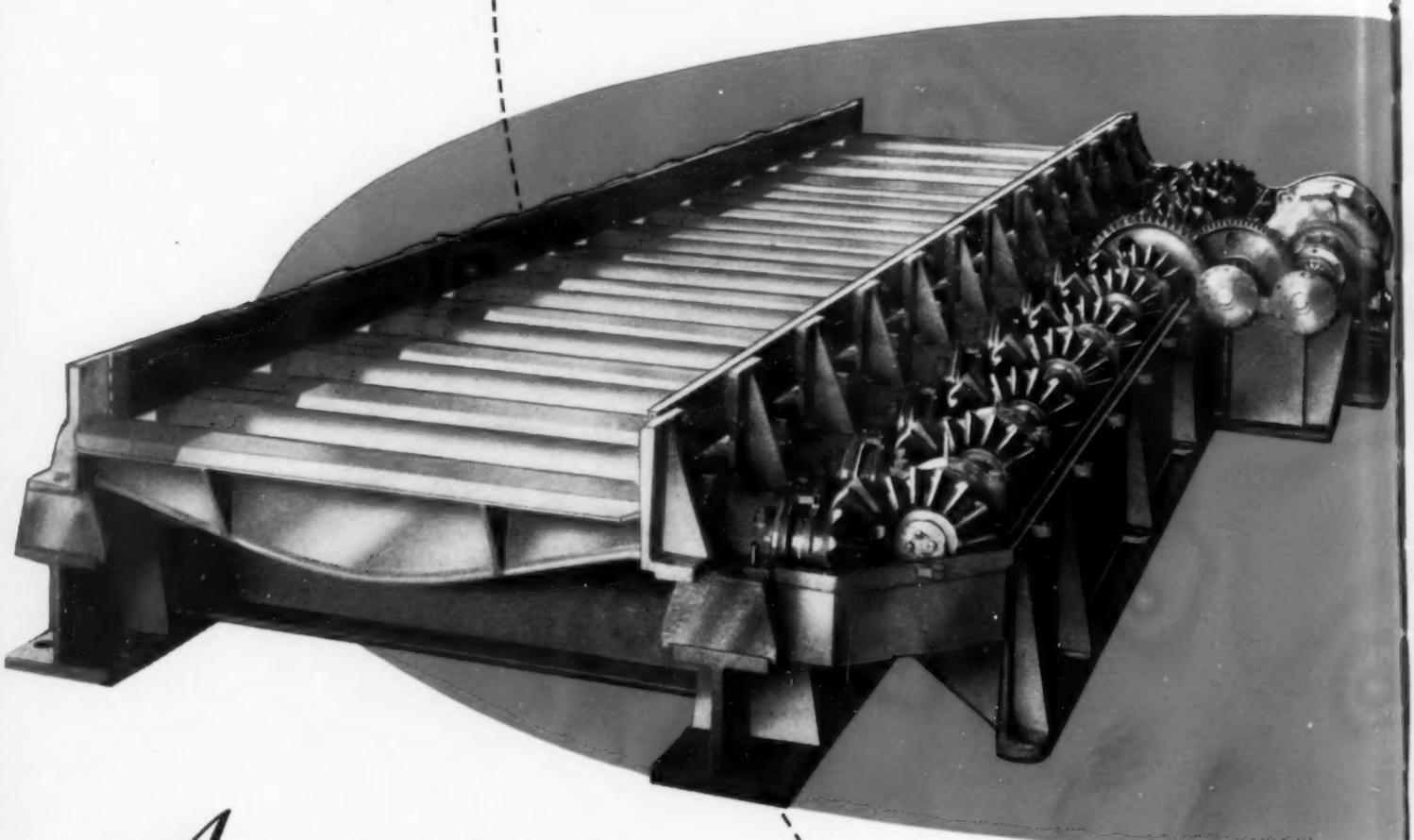
ROLL GRINDING WHEELS

ECONOMICAL conditioning of chilled iron, alloy steel or forged steel rolls is no problem if you standardize on NATIONAL consistently uniform roll grinding wheels in Shellac, Resinoid and Vitrified bonds. Roll shops in steel mills throughout the industry are switching to NATIONAL. Write, wire or phone today for the services of a NATIONAL roll grinding specialist.

NATIONAL GRINDING WHEEL CO., INC. NORTH TONAWANDA, N. Y.

Alliance RUN-OUT TABLES

Designed* to last...
THE LIFETIME OF YOUR MILL



Alliance run-out tables are built to last. One motor drives all rollers, turning them at the same speed. This reduces slippage and assures smooth handling of ingots, blooms and slabs. The gears (shown exposed) driving each roll are totally enclosed and run in oil. A sealed cover keeps lubricant in and dirt out.

Alliance designed and built this trouble-free run-out table to operate efficiently for the lifetime of a mill. Depend upon Alliance to build the best.

Send your heavy equipment requirements to "the world's largest builders of the world's largest cranes".

LINK DRIVE ROLLERS

Uniform roller drive on the new Alliance run-out table moves steel more smoothly and keeps friction to a minimum, lengthening the table's service life.

"Give us the Runway and we'll lift the World"

THE Alliance MACHINE COMPANY

FOUNDED 1901

MAIN OFFICE ALLIANCE, OHIO

World's largest builders of world's largest cranes

Manufacturers of:

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLET CHARGING MACHINES • OPEN HEARTH CHARGING MACHINES • SPECIAL MILL MACHINERY • STRUCTURAL FABRICATION • COKE PUSHERS • ORE BRIDGES • SHEET CARRIERS

Equipment News...

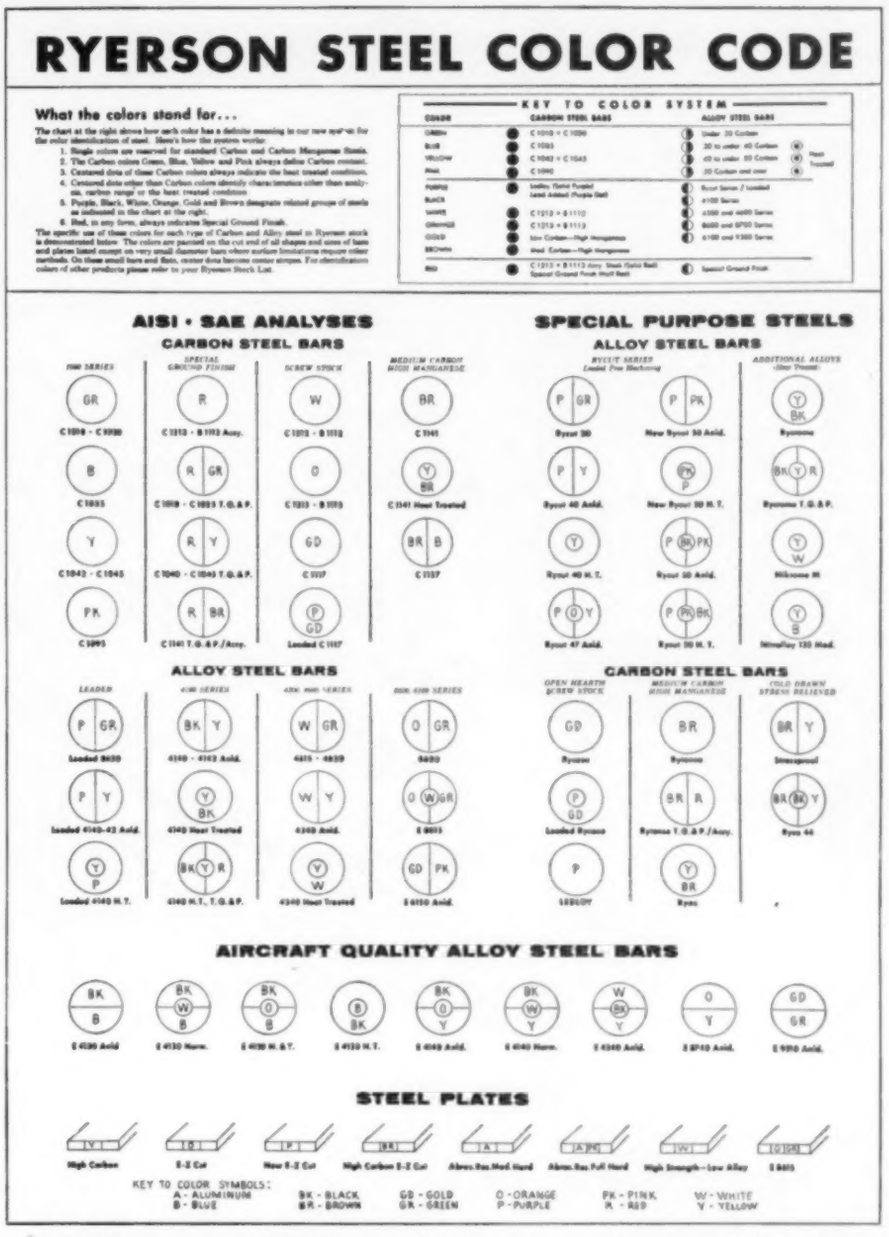
REVOLVING RAM TRUCK

▲ A revolving ram truck built by Automatic Transportation Co. will lift and carry up to 70,000 lb. With additional counter-weighting its capacity can be increased to 100,000 lb.

Designed for the transportation and storage of huge steel coils in a Welsh rolling mill, this giant truck has two other unusual features, aside from its size. Its motorized revolving load ram permits the truck to wind the loose ends of coils as it transports them, eliminating the need for manual winding or steel strapping. Secondly, the truck is engineered and equipped for the later addition of an attachment which will up-end coils and stack them vertically. Besides eliminating the expense of a coil up-ending unit as part of the rolling mill installation, this attachment is so designed as to prevent costly damage to the ends of the coils.

The truck was built for the Steel Company of Wales, Ltd., to be used in their Abbey Works at Port Talbot, Glamorgan, South Wales. The Welsh firm already employs a fleet of 25 Automatic trucks to add speed and flexibility to the coil handling operations in their rolling mills. Since these trucks can be moved around the plant at will, they are far more versatile than cranes and conveyors.

With an overall height of 184-in., the truck will lift a coil 126-in.



Key to the successful development of the new Joseph T. Ryerson & Son., Inc., steel color identification system is in the use of color. Single colors are reserved for standard carbon and carbon manganese steels. The carbon colors green, blue, yellow and pink always define carbon content. Centered dots of these colors always indicate the heat treated condition. Alloy steels, in the main, are designated with two colors, one indicating the particular analysis group and the other the carbon content.

HIGH-SPEED RELAY

▲ The Bristol Co. has announced a new high-speed relay designed for complete reliability in dry-circuit and low power applications. Operation of the relay is unaffected during shock of 30G, and vibration (10-55 cps) of 10G.

Typical performance characteristics include: Temperature range, —55 deg. to + 100 C; contact ratings, up to 28v, 200 ma; pull-in time (including bounce), as low as 200 microseconds; drop-out time, 300 microseconds; stray contact capacitance, less than 15 mmfd. Under these conditions, life expectancy is at least 1000 hours at 400 operations per second.

CRANE CONTROL PANEL

▲ Announced by General Electric Co., is an a-c crane control panel for NEMA Class II service applications.

The panel is designed for use with mechanical load braking systems. It can be tailor-made to meet the requirements of specific applications and can be built for either floor or cab operation.

Among the features of the panel are easy-access wiring, all front-connected devices, and removable doors. The Class II model is available in widths of 20, 30, or 40 in. and in combinations of these widths depending

You Can Be Sure of STRONGER BLAST FURNACE LININGS

after you apply

SUPER #3000 Refractory Bonding Cement

• **MOST RESISTANT**—With but one-tenth the percentage of iron contained in other bonding mortars, Super #3000 shows exceptional resistance to attack by carbon deposition and alkalis on blast furnace stack linings.

• **VOLUME-STABLE**—expanding and contracting with the brick; hence it does not shrink or crack in the joints.

• **MAKES TIGHT JOINTS** that prevent passage of gases into the wall. Used as a wash coat, it reduces oxidation.

• **STRONGEST**—most abrasion-resistant and spall-proof in the hearth, bosh and stack.

• **CUTS MAINTENANCE COST** for materials, labor and outage, and increases blast furnace productivity.

Super #3000 Refractory Cement challenges comparison and investigation. Write for details.

REFRACTORY & INSULATION CORP.

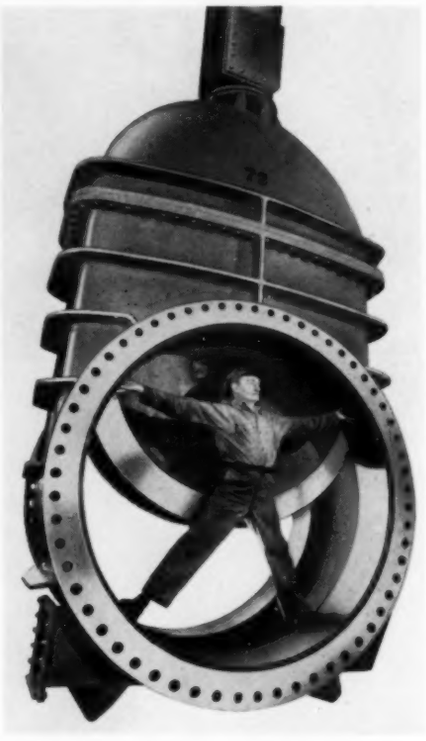
REFRACTORY BONDING AND CASTABLE CEMENTS
INSULATING BLOCK, BLANKETS AND CEMENTS

136 WALL STREET • NEW YORK 5, N.Y.

upon the number of motions required in specific applications. The standard depth is eight in., and the height is set at 15 or 25 in. depending upon the number of devices needed to meet application requirements. This wide range of sizes provides maximum design flexibility.

GATE VALVES

▲ Allied Chemical & Dye Corp.'s Semet-Solvay Engineering Division has announced a new line of hydraulically-operated gate valves ranging in diameter from 24 in. to 72 in.



These valves have reduced the gas flow change-over time from hours to a matter of minutes.

Fabricated from welded steel, stainless steel or special alloys, the new 72 in. gate valves are equipped with an hydraulically actuated mechanism which lets one man open each valve manually in 17 minutes. To open handwheel-operated 72 in. valves takes six men two hours.

GEARMOTORS

▲ A new line of gearmotors now available in both a-c and d-c from one through 60 hp have been announced by Reliance Electric and Engineering Co.

The new gearmotors combine the latest design principles of mechanical gearing and electrical motor development, and are designed and built to

TIPS FROM A ROLL MAKER'S NOTEBOOK

MACKINTOSH-HEMPHILL DIVISION, E. W. BLISS COMPANY, Pittsburgh 3, Pennsylvania

Cast mill rolls • Johnston cinder pots • rotary tube straighteners • end-thrust bearings • heavy-duty lathes • steel and special alloy castings

Choosing rolls for slabbing and blooming mills

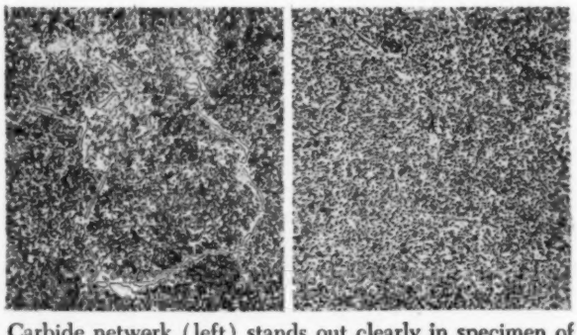
Cast steel rolls for blooming and slabbing mills must combine good resistance to fire cracking with the strength necessary to stand the severe stresses developed by these mills.

Other considerations that affect the choice of rolls include severity of the service and the method of roll cooling. Variations like these can mean good service from inexpensive rolls in one mill while in another the only practical solution lies in costlier, higher alloy rolls.

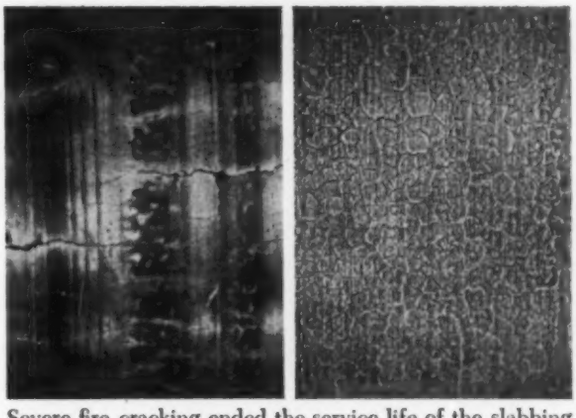
Two heat treatments – Heat treatment is used primarily to improve roll strength. However, heat treatment also affects resistance to fire cracking – metallurgists believe that there is a relationship between fire cracking and the elimination of the carbide network from the crystalline structure of cast steel.

Mack-Hemp has developed two heat treatments for blooming and slabbing rolls. The first is an air quench and draw, and develops maximum strength. It produces rolls with excellent resistance to the very severe localized concentration of stress that occurs each time the steel goes through a pass.

The second heat treatment, a double anneal, produces a spheroidized carbide structure with good strength and excellent resistance to fire cracking.



Carbide network (left) stands out clearly in specimen of roll with ordinary treament. Picral etch, 500 magnifications. Network in Midland Superalloy (right) has been almost completely destroyed by special Mack-Hemp heat treatment. Picral etch, 500 magnifications.



Severe fire cracking ended the service life of the slabbing roll whose surface is shown at the left. Surface of Midland Superalloy roll at right shows excellent fire cracking pattern (roll had reached worn-out diameter after more than 600,000 tons).

Three types of rolls – Both of these heat treatments are modifications of older practices, designed to decrease the amount of grain boundary carbide in the finished roll, thus improving fire cracking resistance. Either treatment can be supplied in the three grades of Mack-Hemp cast steel rolls recommended for slabbing and blooming mills:

Midland Superalloy, a nickel-chrome-moly roll especially developed for applications where fire cracking is a severe problem. There are cases on record where sets of Midland Superalloy rolls have rolled 700,000 tons and more before reaching worn-out diameters.

Technalloy, a chrome-moly roll that has thoroughly proved itself under standard operating conditions.

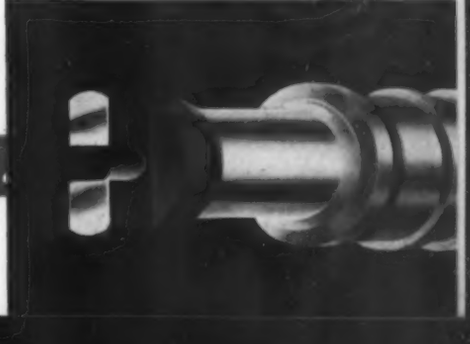
Technisteel, a carbon steel roll which gives good service at low initial cost under mild-to-average operating conditions.

Squeezing maximum tonnages from your mills... at minimum roll cost... is far easier when you enlist Mack-Hemp's aid. For help with your particular rolling problem, write us today.

MACKINTOSH-HEMPHILL

You get more tonnage from the rolls with the Striped Red Wabblers

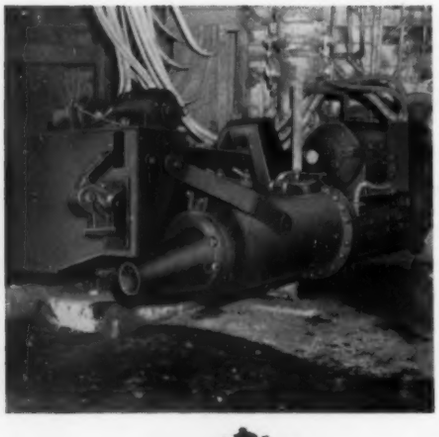
Division of E. W. BLISS COMPANY
PRESSES, ROLLING MILLS, SPECIAL MACHINERY



180 Bailey CLAY GUNS
IN CONTINUOUS SERVICE

Here's Why...

- Exceptional Power
- Accurately Controlled
- Operated by Three Separate Motors



With clay pressures of 600 psi, these guns provide ample power for plugging and maintaining long tapping holes. A unique mounting and operating system assures fast and accurate positioning with the ultimate in safety.

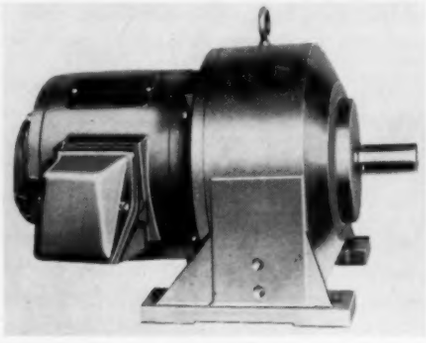
Bailey Electric Plunger Clay Guns are adaptable to both blast furnaces and large electric furnaces.

Write for Bulletin

WILLIAM M. Bailey COMPANY
ENGINEERS
LEADERSHIP THROUGH QUALITY
1221 BANKSVILLE ROAD PITTSBURGH 16, PA

give long trouble-free performance under the most adverse operating conditions.

Two-way seals lock oil in and seal dirt out so that the gearmotors may be mounted in virtually any position without oil leakage. Induction hardening provides extremely hard tooth



surfaces on tough alloy steel gears, making a perfect combination of strength and wear resistance.

The simple gear train is unencumbered by excess mechanisms—with fewer parts to wear, less mechanical friction, and better power transmission.

TABLE ROLLERS

▲ Loewy-Hydropress Division, Baldwin-Lima-Hamilton Corp., has developed an individual, reversible, motor driven table roller unit for heavy-duty service wherever roller conveyor tables are required. They provide high starting torque needed for stop and reverse operations, and are able to withstand the rough handling and heavy service in rolling mills, pipe mills and slab mills.

Each roller, together with its driving motor and anti-friction bearings form a complete interchangeable unit. The supporting member is open at the top to permit lifting the complete roller out without further dismantling. Thus, there are no gears to maintain and the interchangeability feature minimizes the number of spare parts needed.

The motor stator windings are of special fiberglass combination-insulated wire impregnated with silicon varnish capable of withstanding a temperature of 265 F. Liberal cooling ribs are provided and the motor can be stalled under full load for some time without damage. A large cavity around each bearing provides space for high-temperature silicon grease.

The rigid one-piece construction

MORGAN ENGINEERING CO., Alliance, Ohio, uses Timken bearings on the idler and driver track wheels of their 50/20-ton capacity overhead traveling cranes to take heavy thrust loads, reduce friction, keep performance up and maintenance down.

Morgan Cranes move hot slabs fast

...TIMKEN® bearings cut traveling costs

THESE Morgan heavy-duty cranes move hot steel slabs from cars to storage in an Eastern steel mill and do it fast. To be sure they keep rolling and at minimum cost, Morgan engineers mounted the idler and driver track wheels on Timken® tapered roller bearings. They keep them on the go with minimum maintenance.

The tapered construction of Timken bearings lets them take *both* radial and thrust loads in any combination. And full line contact between the rollers and races gives Timken bearings *extra* load-carrying capacity. They can take the heavy thrust loads of crane operation in stride. No additional thrust devices are needed. Longer bearing life is assured. Cranes keep rolling.

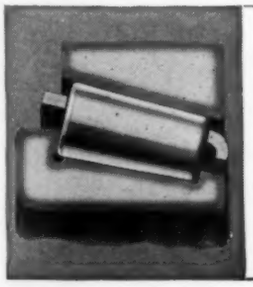
Timken bearings practically eliminate friction because they are designed by geometrical law to have true rolling motion and are made microscopically accurate to conform to their design. Because friction is reduced wheels and loads roll smoothly. Costly maintenance drops, power is saved.

And by holding housings and shafts concentric, Timken bearings make closures more effective. Dirt and dust stay out; lubricant stays in. Lubricant and upkeep costs are also decreased.

What's more, to be sure of toughest, finest bearing steel, we make our own. We're America's only bearing manufacturer that does.

Only Timken bearings give you so many advantages. Always specify Timken bearings for the machines you buy or build. Be sure the trademark "Timken" is on every bearing —it's your assurance of full, money-saving value. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



GREATER LOAD AREA

Because the load is carried on the *line* of contact between rollers and races, Timken bearings carry greater loads, hold shafts in line, wear longer.

Only Timken tapered roller bearings have these advantages: 1. advanced design; 2. precision manufacture; 3. rigid quality control; 4. Timken fine alloy steels.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ⊂⊃ THE TIMKEN TAPERED ROLLER ⊂⊃ BEARING TAKES RADIAL ⊖ AND THRUST —⊖— LOADS OR ANY COMBINATION —✳—

Even truer today

We ran this **B&W Insulating Firebrick** advertisement in 1947

24 years now

Photo courtesy Sun Shipbuilding & Dry Dock Company

Only in main arch approximately 2 feet from each end of the furnace

The furnace that PAID FOR ITSELF MANY TIMES OVER

Still lined with its original B&W Insulating Firebrick after 15 years of normalizing and stress-relieving service, this furnace is giving exceptional performance. Despite the added strain of the rigorous war years, the 80,000 B&W IFB used to line sides, ends and arch have required no appreciable maintenance!

It is no wonder the operators can report:
"This furnace has paid for itself many times over."

For furnace performance that assures highest production at lowest cost, even after years of grueling service, you can always count on lightweight B&W Insulating Firebrick. Your local B&W Refractories Engineer will be glad to help you select economical B&W Refractories for your furnaces.

B&W REFRACTORIES PRODUCTS:

B&W Allmul Firebrick • B&W 80 Firebrick •
B&W Junior Firebrick • B&W Insulating Firebrick
B&W Refractory Castables, Plastics and Mortars
B&W Silicon Carbide

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42ND ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

R580

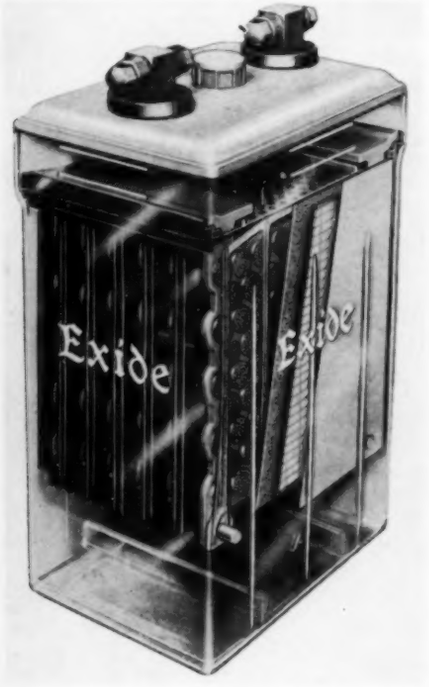
of the roller unit eliminates the complex alinement problems encountered with gear, coupling and shaft drives. Furthermore, trouble in one roller does not affect the entire conveyor table, the rollers idle in case of emergency. Flexibility of installation is unlimited, straight or curved table lines can be formed and foundations are reduced to simple inexpensive blocks.

BATTERIES

▲ Announced by Exide Industrial Division, The Electric Storage Battery Co., is a new line of batteries which feature longer life and higher instantaneous discharge rates.

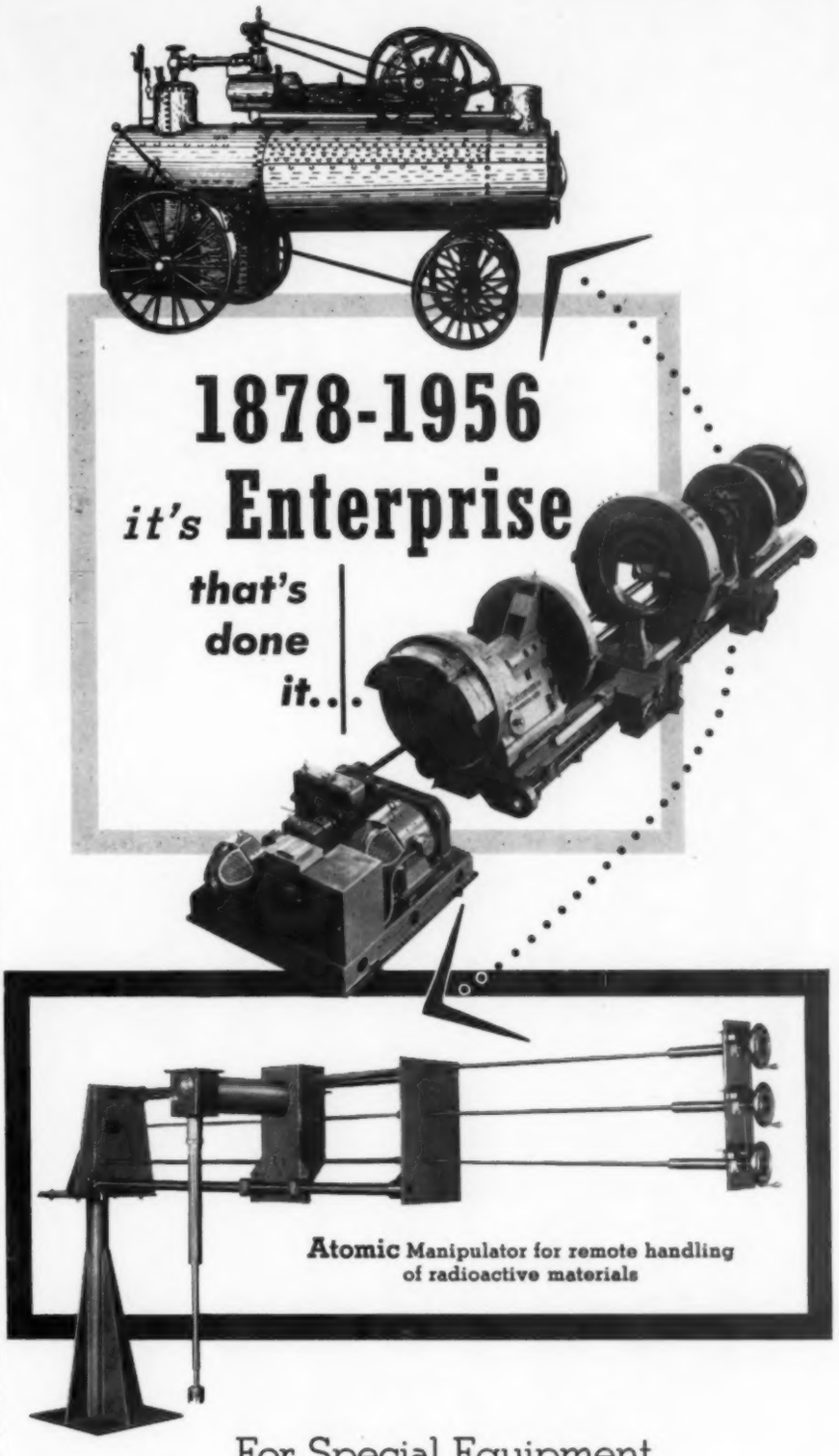
The new batteries, in heat-resistant polystyrene jars, are designed for stationary power applications in utility, telephone, railways and industrial plant operations.

Improvements have been made in these batteries that provide for a ready adaptability to cycle as well



as float service, and reduced maintenance because of less frequent additions of water, more effective sealing, and easier cleaning.

Insulation or spacing between plates of opposite polarity consists of molded one-piece polystyrene dowels and microporous rubber separators. The dowels accomplish perfect alinement between plates and greater access of electrolyte to the Manchex positive plates, resulting in better electrical characteristics.



For Special Equipment
New Machine Design
High Quality Machine Manufacture
. . . it's Enterprise that counts!

The Enterprise Company
COLUMBIANA • OHIO

DURASPUN

20-FOOT FURNACE ROLLS
Centrifugally Cast

. . . of Duraloy HH Alloy, one of the most widely used high chrome, medium nickel alloys.

Two items concerning these furnace rolls may be of particular interest:

a—the size: 20 feet long—14" OD, ¾" wall thickness

b—*welding operations* by which reducing cones and shafts (both statically cast of the same alloy) were welded to the centrifugally cast rolls

These two items will serve to emphasize two phases of our service: (1) the large size centrifugally cast tubes we are able to produce and (2) our machining and finishing facilities, including welding.

Our new 16-page general Bulletin — 3354-G — gives complete details. Would you like a copy? When writing or calling would you mind telling us the general nature of your high alloy casting requirements? Better yet, if you have specific requirements on which we could help, let us have the details.

THE DURALOY COMPANY
OFFICE AND PLANT: Scottdale, Pa.
EASTERN OFFICE: 12 East 41st Street, New York 17, N. Y.
DETROIT OFFICE: 23906 Woodward Avenue, Pleasant Ridge, Mich.
CHICAGO OFFICE: 332 South Michigan Avenue

The new design jars and covers are made of light-weight, heat resistant and shock absorbing polystyrene. The jars are designed so as to provide increased volume of electrolyte. Additional electrolyte reduces the need for water addition to replace evaporation. A unique method for suspending the elements in the larger size jars is accomplished by support ledges molded into the jar walls.

Covers are effectively sealed to the jars and terminal posts to keep out dirt and prevent leakage of electrolyte.

The large electrolyte reservoir at the bottom of the jar provides ample space between the bottom of the plates and the jar to accommodate the full amount of sediment whether it be in float or cycle service.

SPEED DRIVE

▲ Developed by Eaton Manufacturing Co., is an adjustable speed, fractional horsepower drive with integral electrically operated fail-safe friction brakes. The brakes are available in two ratings — 18 and 36 lb in. of torque.

The small single package drive is an integral combination of a-c constant speed induction motor, eddy-

current coupling, friction brake and electronic control. A simple connection to a standard power line is the only wiring required. All drives have a continuous constant torque rating through a 25:1 speed range. Electronic control insures speed stability of plus or minus 2 per cent of top speed at any point within the operating range.

BURNERS

▲ North American Manufacturing Co., has announced a new line of sealed-in burners. At 16 osi air pressure the burner's capacity is 4,850,000 Btu per hour, equivalent to about 4,850 cfh of natural gas or 35 gphr of oil.

Why NATIONAL TRADE-MARK *brushes*

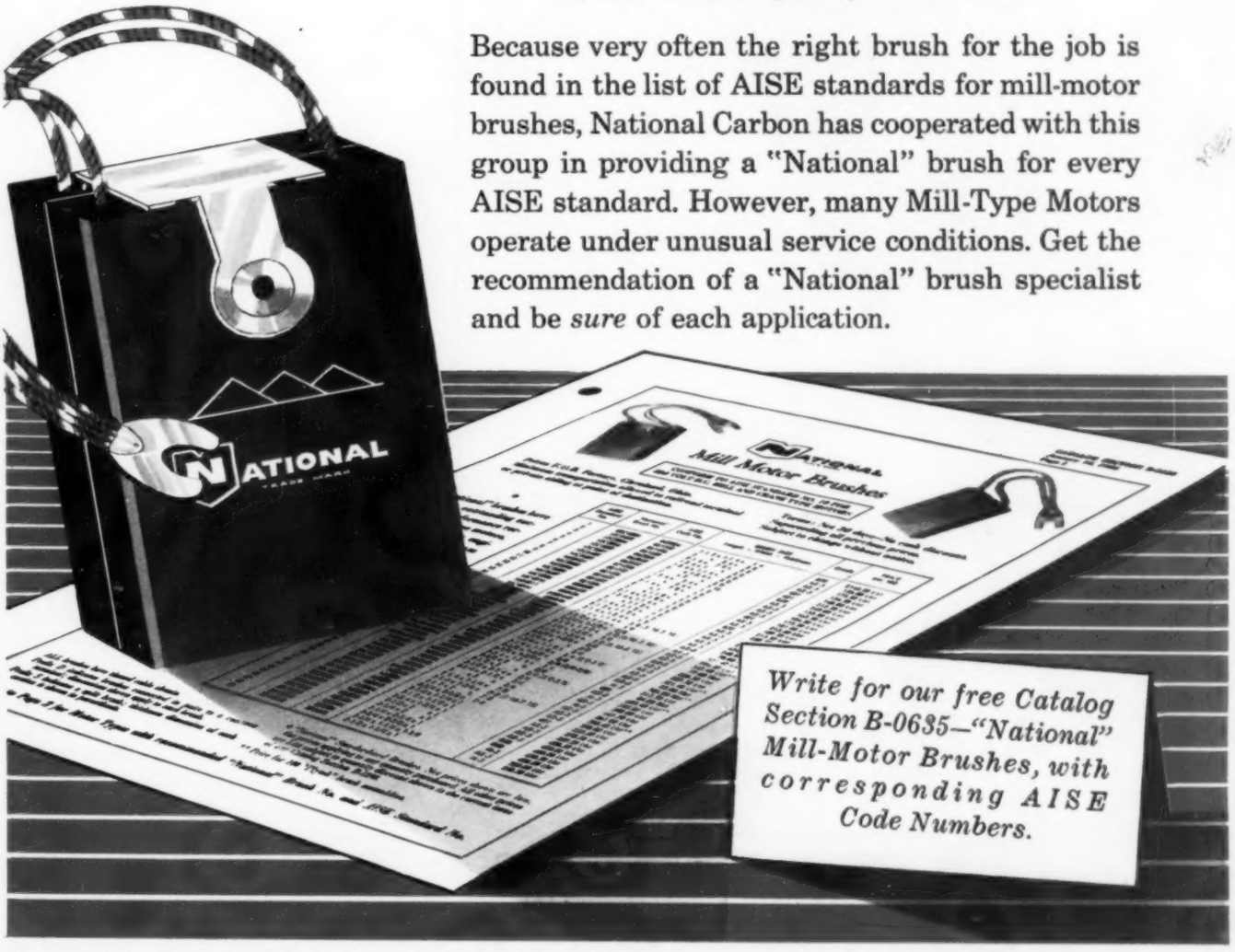
are best for

MILL-TYPE MOTORS

National Carbon's complete line of motor brushes includes a grade, size and design that is best for every motor application in your mill. Here, for example, are two good reasons why "National" brushes are your best buy for Mill-Type Motors:

- **High strength for tough reversing service**
- **Superior commutating ability for load fluctuation**

Because very often the right brush for the job is found in the list of AISE standards for mill-motor brushes, National Carbon has cooperated with this group in providing a "National" brush for every AISE standard. However, many Mill-Type Motors operate under unusual service conditions. Get the recommendation of a "National" brush specialist and be *sure* of each application.


NATIONAL
Mill Motor Brushes
Write for our free Catalog Section B-0635—"National" Mill-Motor Brushes, with corresponding AISE Code Numbers.

The term "National", the Three Pyramids Device and the Silver Colored Cable Strand are registered trade-marks of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY • A Division of Union Carbide and Carbon Corporation • 30 East 42nd Street, New York 17, N. Y.

Sales Offices: Atlanta, Chicago, Dallas, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco. *In Canada:* Union Carbide Canada Limited, Toronto

HERC-ALLOY

THE ORIGINAL ALLOY STEEL CHAIN

- Herc-Alloy is a special all-purpose chain with long-wearing properties and high resistance to impact loading.
- Herc-Alloy is sold in running lengths and in all types and sizes of sling chains assembled to customers' specifications.

- Write for Bulletin 100 covering Herc-Alloy Sling Chains, including helpful information on their care, use and inspection.

- CM also produces a complete line of chain attachments and welded chain of all types including stainless steel and bronze.

CM HOISTS AND CHAIN

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Tonawanda, New York
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In Canada: McKINNON COLUMBUS CHAIN LTD., ST. CATHARINES, ONT.
Herc-Alloy®

All six sizes of these burners produce a stable fire on light-up without need for a constant pilot. They will operate in cold, tight furnaces under positive pressure, and are four-pipe burners. Atomizing air may be left on during gas operation to give capacity equal to that obtained with light or heavy oil. These sealed-in burners have provision for mounting flame safety devices such as a flame rod, photo cell, or flicker cell. The burners are furnished with an observation port, complete with tubing and fittings to introduce some atomizing air into the mounting to keep the port clear at all times for good observation.

HOT BLAST VALVE

▲ S. P. Kinney Engineers, Inc. has recently been granted exclusive rights for the manufacture and sale of the Dango & Dienenthal hot blast valve in the United States. The valve is manufactured in sizes ranging from 12 in. to 54 in.

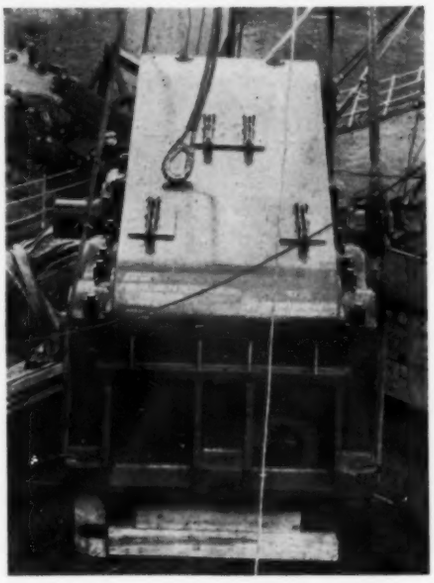
The body of the valve is manufactured in a single piece of heavy duty cast steel construction, ribbed for high pressure operation. This single piece heavy duty cast steel body eliminates one source of leakage and effectively withstands excessive strains caused by high temperatures. The hood covering the top of the valve is normally of cast iron and is also built for high pressure operation.

The valve is provided with water-cooled seats and paddle. The seats and paddle are constructed of high quality copper, or if desired, may also be furnished from fabricated steel. The two seats are packed with asbestos and lined at the outside with refractory brick.

The use of a single piece body permits installation of the cooling seats in the body of the valve without fastening by bolts. The seats are held in the body by three supporting rings, locked into place by a key ring. With this arrangement, an ideal screwless installation of the cooling seats is provided and asbestos packing can be inserted between the seats and the valve body.

With the valve in the closed position, the paddle hangs from the cooling pipes and swings between the two cooling seats. The pressure of the hot air presses the paddle against one of the seats, giving an absolute tight closure.

GEAR DRIVE



This 108-ton, 2000-hp gear drive for Manufacturas Metalicas Madrilenas, Madrid, Spain, is part of a steel finishing plant being supplied by Blaw-Knox Co. for the Spanish firm. Other components already shipped to Madrid are one 3-high and two 2-high, 62-in. finishing mills; furnaces, tables, and double piler. The mill is expected to be in operation later this year.

The valve is normally equipped with two flexible cooling pipes, running side by side. The smaller size valves may be furnished with only one cooling pipe. With the single cooling pipe, a smaller pipe is inserted into the paddle stem, serving as a return conduit. On special installations, the paddle may be constructed with spiral passageways, allowing a controlled and even distribution of the cooling water throughout the paddle. Special labyrinth packing in the valve hood permits a lateral displacement when the paddle is in motion.

The valve may be operated manually by hand lever, counterbalanced to compensate for the weight of the paddle, or on the larger valves, by a hand winch. The valve may also be automatically operated — by an electric motor or by means of a hydraulic or an air cylinder.

All parts of the valve are subjected to pressure tests after assembly.

STEEL MILL TRUCKS

▲ A new medium capacity range line of electric powered steel mill trucks which feature smaller overall dimensions, hydraulic wheel brakes and a hydraulic tilt feature for load safety has been announced by the Yale & Towne Manufacturing Co.

The line of 18,000 to 30,000 lb capacity trucks can be equipped with forks, a ram or a hydraulically operated split ram.

These trucks provide amounts of lift per overall height equal to the maximum in the industry achieved by mounting the lift channels between the wheels.

Every truck can be equipped with a five degree backward and three degree forward tilt feature.

It can be powered with a battery or a diesel or gasoline engine generator power plant. Steering effort is considerably reduced in these trucks through hydraulic power steer.

All trucks in this series are made with dual operating controls on either side of the truck to give the operator maximum visibility regardless of the conditions under which he is working.

Another important feature is the "dead axle" in the drive unit. Drive gears completely sealed and running in oil, are mounted directly onto the wheel hubs allowing for the use of a heavy rugged axle and permitting easy wheel demounting.

PIT COVER CONTROL

▲ A new electronic system for the opening and closing of soaking pit covers from a crane has been developed by Femco, Inc. It operates over the existing power system.

The equipment will select and operate up to fifty separate covers from a soaking pit crane. Installation can be made for a few or many soaking pits.

Value features of the system include time-saving, safety, increased production, improved coordination and better teamwork. A specific feature is that the pit cover can be opening while the crane is approaching the pit.

Crane-mounted equipment consists of a carrier transmitter in a compact steel case, a control unit with a switch for each pit cover and a common switch to operate the cover selected.

Floor equipment consists of a central cabinet with space for carrier-current receivers and their power supplies. Separate pit cover control relays operated from the associated

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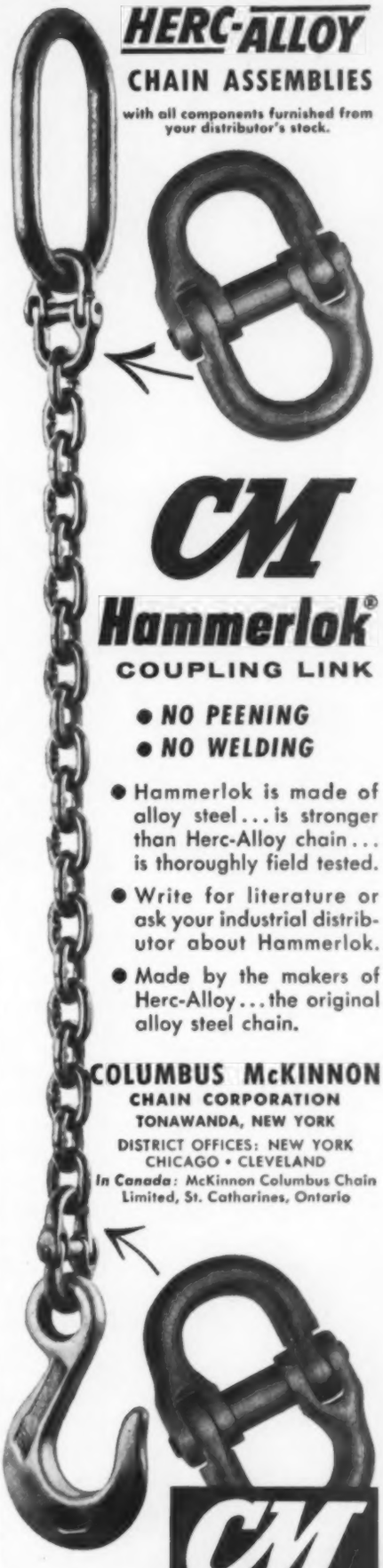
with all components furnished from your distributor's stock.



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Please note that this is NOT a special sale! Bargains like this are yours for the asking the year 'round when you specify Pennsylvania *Standard Parts* Power Transformers. You can save as much as *8% of the basic price* of a conventional power transformer rated 69 kv and below . . . and the sizes range from 833 through 5000 kva, single phase, and from 750 through 10,000 kva, three phase. You have a wide choice of voltage combinations and accessories, too . . . with little effect, if any, on price.

Check the other outstanding advantages of *Standard Parts* Power Transformers . . . then check your pending power transformer needs. If your system requirements permit using the kva sizes, voltages, impedances, and accessories within the range of standardized units outlined in ASA Standards C57.12b, it will pay you to specify Pennsylvania *Standard Parts* Power Transformers.

GET QUICKER DELIVERIES . . . because designs are already made up, and many standard parts are kept in stock.

SAVE ON INSTALLATION . . . because most Standard Parts Power Transformers are shipped completely assembled.

SAVE ON MAINTENANCE . . . because Pennsylvania Standard Parts Power Transformers feature all-sealed construction, with no auxiliary tanks and fittings to maintain.

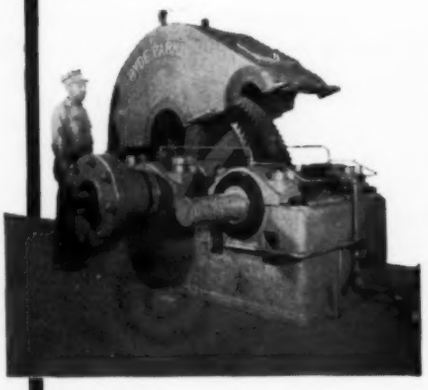
PENNSYLVANIA TRANSFORMER COMPANY
A McGraw Electric Company Division CANONSBURG, PA. Greater Pittsburgh District

Hyde Park

RED CIRCLE Rolls ALLOY-CHILLED

Gray Iron Castings

Hyde Park Castings up to 80,000 pounds are sound, accurate and physically dependable.
Precision machining is done by skilled craftsmen in our modern machine shop.
Send your blue prints for quotation.



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Machine Castings
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For finer finish, long life and greater tonnage, specify Red Circle Rolls.

Hyde Park

FOUNDRY & MACHINE CO.
Hyde Park, Westmoreland County, Pa.
ROLLS
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GREY IRON CASTINGS

crane receivers are mounted in the same cabinet for ease of maintenance. All panels are standard 19 in. rack construction with plug connectors for each panel. The complete unit inside of the cabinet is mounted to swing out for inspection so that the cabinet may be wall mounted where space saving is a factor. External power to operate equipment on the crane is 230 volt d-c and for the floor equipment, 110 volt, 25 cycle or 60 cycle, or 250 volt d-c.

HARDNESS TESTER

▲ A combination Micro-Hardness Tester and metallurgical microscope, a non-destructive type, with a load-weight range of from 25 to 1000 grams, and requiring only one minute for a complete test cycle, has been announced by the Sheffield Corp.

Interchangeable vise accessories permit this instrument to be used for

testing small precision ground or lapped parts, small diameter wires, very thin materials or material coatings, thin sheet stock, cutting tool edges and ball bearings.

A green light in the head of the instrument shows when the indenter is in contact with the work, and a red light indicates when load cycle is complete.

Vertical capacity is 2⅜ in., and the maximum spread of standard vise jaws is $1\frac{11}{16}$ in. Surface finishes of 40 rms or less can be inspected, and indentations of .0004 in. or smaller can be measured to within an accuracy of .00008 in. The spot to be

LUBRIPLATE No 630-AA IS PRACTICALLY A UNIVERSAL LUBRICANT

—says
THE SPOKANE PORTLAND CEMENT CO.

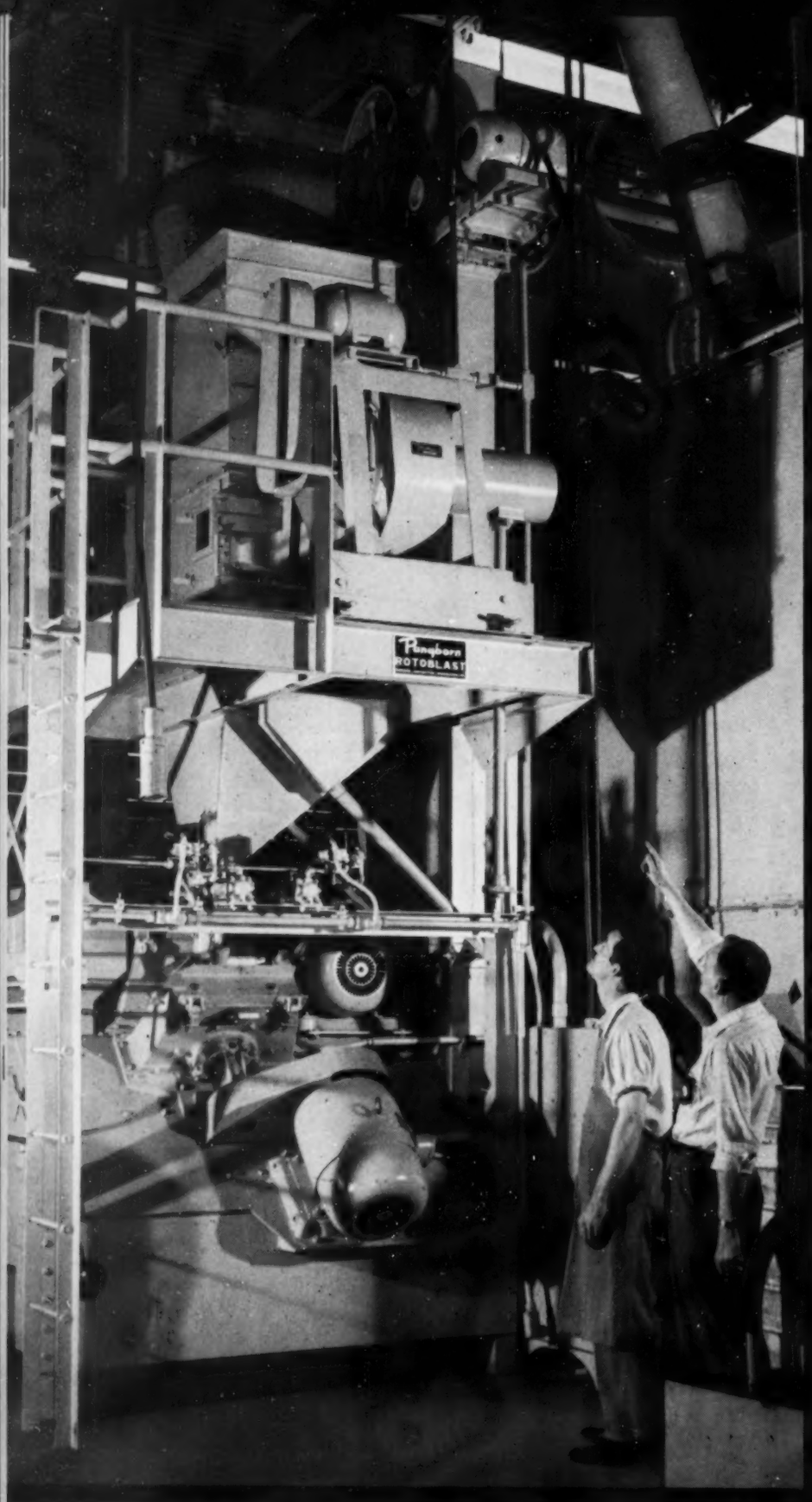
"With the introduction of LUBRIPLATE No. 630-AA, we were able to satisfy all our needs for solid type lubricants with only two LUBRIPLATE Products. LUBRIPLATE No. 630-AA might almost be considered a universal lubricant. Furthermore, it has effected marked savings in both lubricants and labor!"

REGARDLESS OF THE SIZE AND TYPE OF YOUR MACHINERY, LUBRIPLATE LUBRICANTS WILL IMPROVE ITS OPERATION AND REDUCE MAINTENANCE

LUBRIPLATE LUBRICATION MAKES CARS AND TRUCKS RUN BETTER AND LAST LONGER

LUBRIPLATE H.D.S. MOTOR OIL . . . THE OIL THAT NEEDS NO ADDITIVES

For nearest LUBRIPLATE distributor see Classified Telephone Directory. Send for free "LUBRIPLATE DATA BOOK" . . . a valuable treatise on lubrication. Write LUBRIPLATE DIVISION, Fiske Brothers Refining Co., Newark 5, N. J. or Toledo 5, Ohio.



This special Pangborn Rotoblast® machine saves Hamilton Standard $20,000 a year!

The special Pangborn Rotoblast Blast Cleaning Machine at left was designed by Pangborn for Hamilton Standard Division of United Aircraft Corp. This installation is used for blast cleaning and shot peening . . . saving Hamilton $20,000 a year. Below is another special Pangborn machine, owned by Parish Pressed Steel Division of Dana Corp., Reading, Pa. This Rotoblast Descaling Machine is used to clean steel sheets and coiled strip ranging in widths from 19″ to 60″ at a line speed of from 80′ to 150′ per minute.

These are just two of hundreds of special Pangborn machines used throughout the country—to clean parts that are fragile, odd-size or present some other obstacle to usual cleaning methods. If you have such a problem, Pangborn engineers will study it and its relation to your production line. The result will be a Pangborn machine designed especially to give *you* better cleaning and faster production at lower cost. Write today for Bulletin 227 to PANGBORN CORPORATION, 4400 Pangborn Blvd., Hagerstown, Md. *Manufacturers of Blast Cleaning and Dust Control Equipment.*

Pangborn

BLAST CLEANS CHEAPER

Rotoblast Blastmaster® & Continuous-Flo Barrel

Rotoblast Tables & Table-Rooms

Special Blast Rooms & Cabinets

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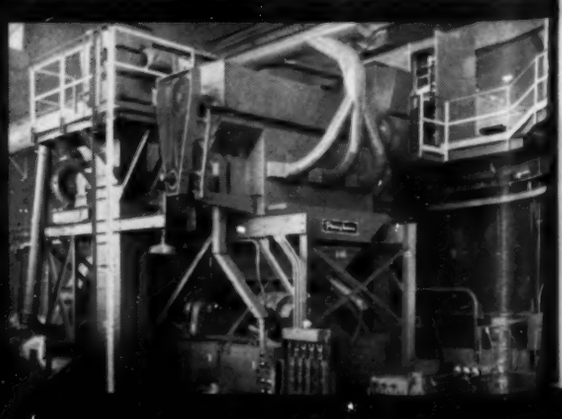


indented can be located to within an accuracy of .0002 in.

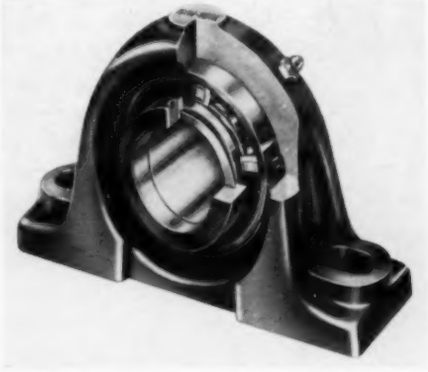
The work piece is raised to the indenter by handwheel. A specially designed loading system, with the load applied in a direct vertical motion perpendicular to the work, eliminates indenter side thrust and deformed indentations which might cause incorrect reading of hardness value.

When the instrument is used as a metallurgical microscope, the interchangeable objective lenses provide magnifications of 200X and 400X. A camera can be attached to the eyepiece for making photomicrographs.

BEARING MOUNTS

▲ A new unit pillow block and a new unit flanged mounting for anti-friction bearings have been developed by SKF Industries, Inc.

These new units are of the eccentric lock type, thus extending use of the positive seal mounts to applications where an eccentric lock is desired. The unit pillow block also has a reduced center height to permit its use where space is limited.



Special design features include: positive sealing through the use of duPont "Fairprene" washer to retain lubricant; an external rotating flinger to keep out dirt; a spherical outer ring to compensate for initial misalignment and a convenient relubrication fitting.

In place of the separate locking collar and set screws of the basic design, the units are provided with eccentric locks for applications where this type is desired.

MULTIPLE TUBE COLLECTOR

▲ Research-Cottrell, Inc. has announced a mechanical collector of the multiple tube type incorporating new design principles to increase gas handling capacity. Designated the "Cyclo-trell," the new design has a higher collection efficiency and a greater gas flow for a given pressure drop than has been previously obtainable in conventional multiple tube collectors. The greater capacity means fewer tubes per unit are needed, resulting in a lower total cost for a given capacity and efficiency.

The collector consists of a series of cyclone tubes arranged in parallel, and depends on centrifugal force for its operation. The incoming gas enters the chamber under pressure, and flows into the lower set of inlet tubes which are attached to the lower header plate and are of slightly larger diameter than the upper outlet tubes. Specially designed inlet vanes at the mouth of the inlet tubes set up a circular motion in the gas so that suspended particles are forced downward and outward against the wall of the inlet tube. Cleaned gas is first forced toward the center of the col-

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lector tube and then upward and into the outlet tube by the pressure differential.

The purpose of the inlet vanes is to start a fast spiral of incoming gas with a minimum of turbulence. The faster the gases spin the greater the centrifugal force on the suspended dust in the gas stream. "Drop out" and collection efficiency are higher as this centrifugal force is increased. The use of aerodynamically shaped vanes, developed after extensive experimentation, minimizes gas turbulence and increases the centrifugal force.

The outlet vanes serve the function of recovering energy in the outlet tube, thus increasing the capacity of the tube. This results in fewer tubes per unit. The vanes are positioned below the tube to decrease entry losses at the tube.

SPRAY NOZZLES

▲ Announced by the Spraying Systems Co. is a new WhirlJet spray nozzle for installation on walls or manifolds. Because the outlet end is directly opposite the inlet, nozzles may be mounted in a straight line if desired, to simplify the job of drilling and tapping holes in a manifold or wall. These nozzles provide a hollow cone spray and are available in two types, the BD 10 WhirlJet with $\frac{3}{8}$ in. male pipe connections and the BD 50-50.3 WhirlJet with $\frac{3}{4}$ in. male pipe connection.

The nozzles are designed without internal cores for clog-free operation and give uniform spray distribution. Because the major portion of each nozzle, when installed, is enclosed by wall or manifold little nozzle area is exposed as a condensation surface for floating water particles to keep afterdrip from nozzles at a minimum.

SEAM WELDER

▲ The Taylor-Winfield Corp. announces an improvement in the conventional welder for joining ends of strip together for continuous operation on galvanize, terne, tin, anneal and other continuous processing lines.

This new welder incorporates the shear into the welder so that overlap at weld is restricted. Tail end of preceding coil is sheared and welded to lead end of following coil quickly, while further line processing is operated continuously.

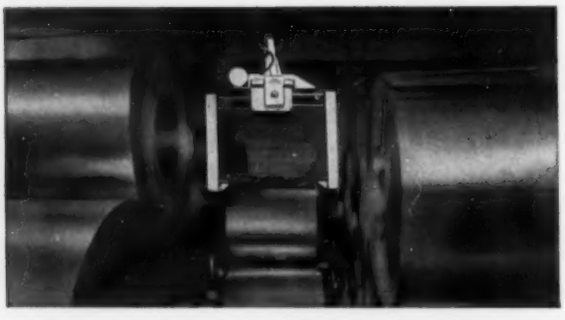
The second improvement is the addition of an adjustment for the lower welding platen, minimizing electrode maintenance. Five and six new welding surfaces are available with the adjustment. The mandrel can be reversed so that an additional five or six surfaces can be used on the lower side.

Book Reviews . . .

"Electronic Engineering" by Samuel Seely, published by McGraw Hill Book Co., Inc., 330 W. 42nd Street, New York 36, N. Y., contains 525 pp., 6¼ x 9¼, cloth bound and sells for $8.00. This book is a detailed discussion of a large variety of electronic circuits important in radar, television, electronic control and instrumentation, and computers, beginning with a general introduction to tubes and tube circuit principals and proceeding into detailed consideration of electron tube circuits with emphasis on the physical and mathematical analyses. All analyses include requisite reference conditions for potential polarities, current directions, and transformer-winding sense. In addition to the analyses of circuit operation, some of the factors necessarily considered in circuit and systems synthesis are discussed. The material is developed by employing varied analytical methods and occasional alternate methods of analysis of a given circuit, examples and problems are used to relate the theoretical developments with practical situations. A complete handling of the overall scope of electronic engineering advances an understanding of the techniques of analysis, the special features of the many circuits examined, and ways for combining different type circuits to achieve many operational results. With the increasing application of electronics by the steel industry, the book can be of value to those interested in such equipment.

"Heating Ventilation Air Conditioning Guide 1956" the 34th edition has been just recently published by the American Society of Heating and Air-Conditioning Engineers, Inc., 62 Worth Street, New York 13, N. Y.

MANSAVER® GRABS For Handling Coils



On the Galvanizing Line

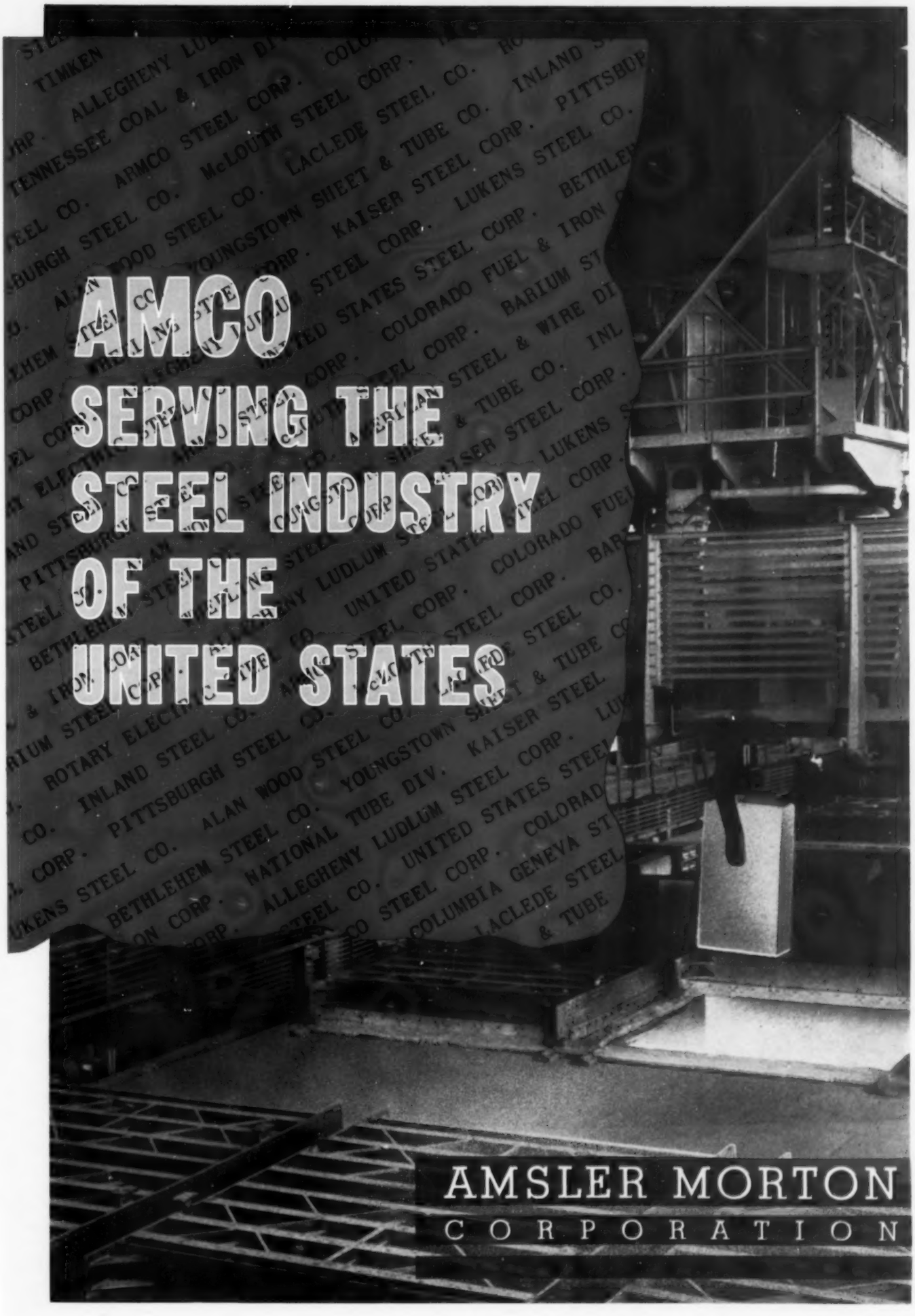
Here is a Style G-1418 Mansaver in a large galvanizing plant. Note how closely and evenly coils are being stacked—made possible by this Grab's unique "telescoping" construction. This same Grab will handle coils from 20" to 48" in width. Imagine the space saving this makes possible as against the use of a Grab with fixed top member, or with a "C" Hook!

This Grab may also be had with motor-driven turntable, which makes it possible to rotate a coil until exactly in the correct unwinding position. Send for complete Mansaver catalog and investigate Mansaver economies first hand.

MANSAVERS—Built to PREVENT ACCIDENTS & PRODUCTION DELAYS—Not for LOW FIRST COST!

SEE THEM at M.H.I EXPO. Cleveland, June 5-8 Booth 411

MANSAVER INDUSTRIES, INC., 3116 East St., New Haven, Conn.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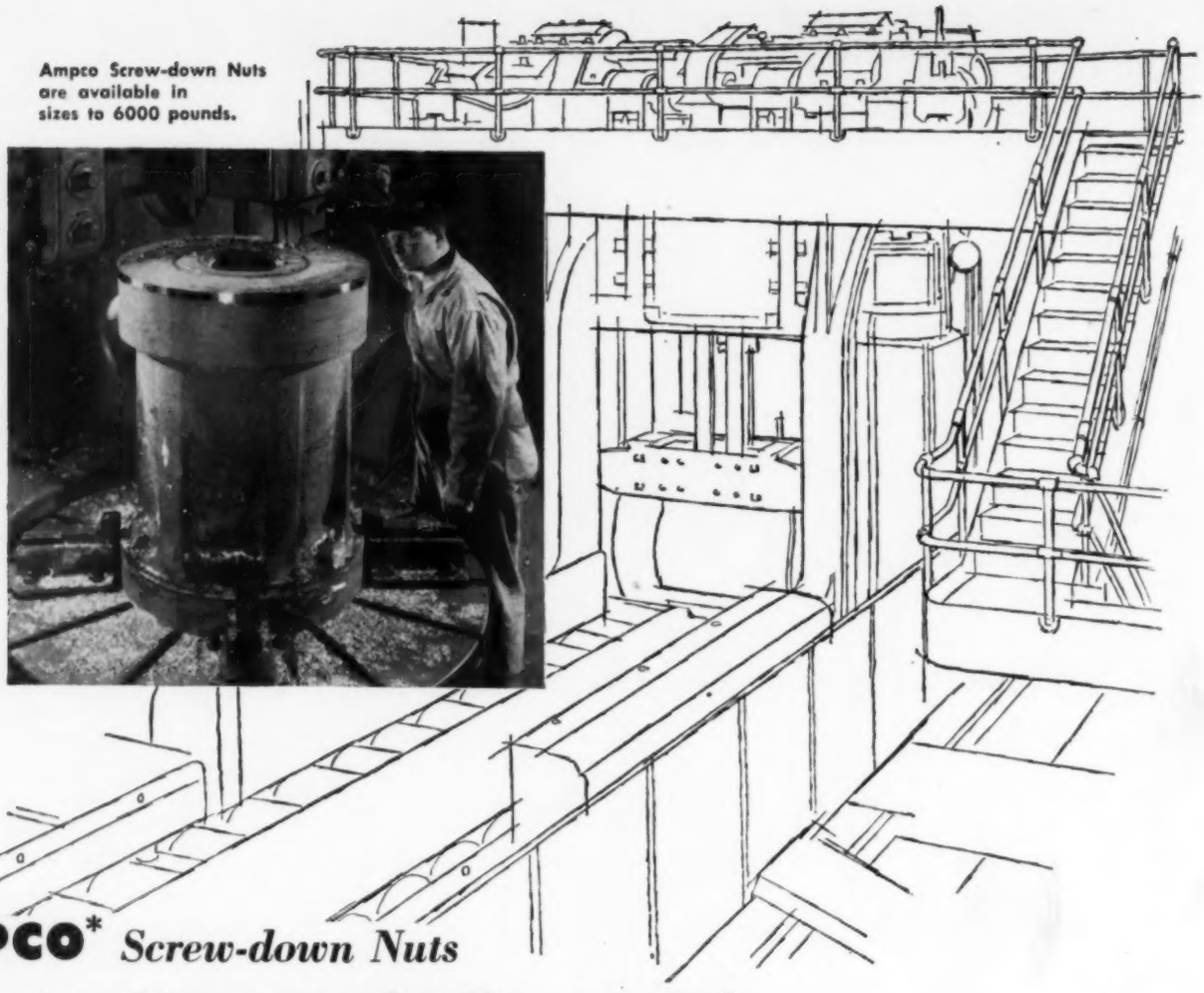


Ampco Screw-down Nuts are available in sizes to 6000 pounds.

AMPCO* *Screw-down Nuts*

help strip mill set production record

— handle extreme pressures to avert costly downtime and replacement

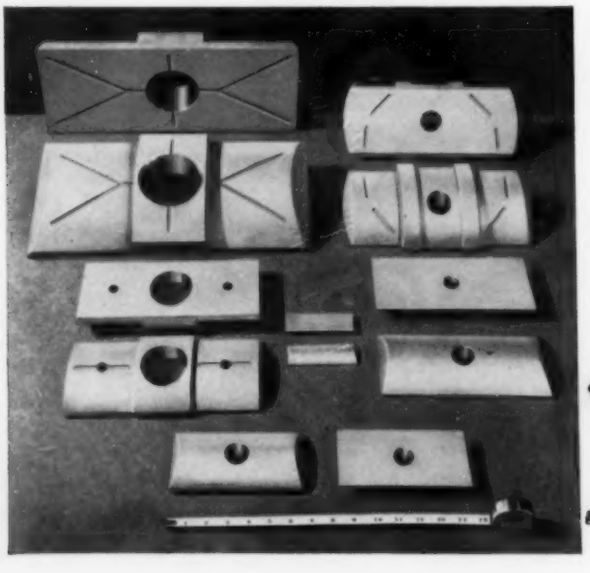
Here's where Ampco Metal's good bearing qualities, high compressive strength and ability to withstand tremendous impact and shock loads really pay off. Ampco Screw-down Nuts eliminate expensive adjustment and downtime . . . don't squash out. For example, one stand of an 80″ hot strip mill using Ampco Nuts, utilizes 4500 hp at speeds up to 282 rpm. That means "king-size" stresses and strains. Yet the records show that in spite of normal screw-down pressures of between two and three million pounds, this mill produced over three million net tons of steel in 1953. Virtually no time was lost for screw-down nut replacement or adjustment.

Ampco Screw-down Nuts are centrifugally cast to insure sound structure and good wear resistance. They're available in sizes to 6000 pounds.

And Ampco slippers help keep mills running longer, too, because they have remarkable stamina . . . real resistance to wear and punishing shock loads. Mills that set production records depend on Ampco slippers to end frequent replacement — reduce spindle wear.

Slippers are available as rough castings or "cast-to-size" — minus 0, plus 1/32″ or plus 0, minus 1/32″. Oil grooves are cast in — if you want them.

Find out how these and other Ampco products provide real dollars and cents savings in *your* mill. Contact your nearest Ampco field engineer or write us direct.



Ampco Slippers available either as rough castings or "cast-to-size." Oil grooves can be cast in.

AMPCO

Sole producer of genuine Ampco Metal

*Reg. U. S. Pat. Off.

G-27

Ampco Metal, Inc.

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West Coast Plant • Burbank, California

The book contains 1696 pages, 6 x 9 in., is cloth bound and sells for $12.00. Substantial improvement has been made in this edition, some chapters have been wholly rewritten with special attention to subjects dealing with heat transmission of building materials, cooling load, chimneys, estimating fuel consumption, baseboard and finned-tube radiation, snow melting, central systems for air conditioning, air duct design, air heating and cooling coils, automatic control, pipe and tube characteristics and insulation, automobile air conditioning, heat transfer measurements, and codes and standards. Revisions have been made in several terminology definitions to obtain agreement with values adopted by the General Conference on Weights and Measures. The book is of value in keeping users abreast of current practice in the heating, ventilating, cooling, and air conditioning field.

"Foundation Engineering" by Rolt Hammond, recently published by the Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y., contains 192 pp., 6 x 9 in., cloth bound, and sells for $10.00. The author has drawn from extensive experience for many of the problems and solutions used as examples in the book, and also discusses other projects from various parts of the world. Explanations and descriptions are illustrated with photographs of actual construction and the problems they presented, as well as by special line-drawings. The book deals exclusively with practical foundation problems and their solutions, and concisely covers a scope which includes soil mechanics and site exploration, foundations for buildings, bridges, maritime structures and precision machinery.

"Fundamentals of Press Tool Design" by W. F. Walker, has recently been published by the Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. The book contains 152 pp., 5½ x 8¾ in., is cloth bound, and sells for $4.75. It identifies and explains the fundamental requirements, necessary for each different press operation, so that efficient and economically operated tools may be designed. A chapter on cutting operations is supplemented by detailed information on designing tools for over twenty different press operations with many variations of each operation illustrated by a series of drawings. Singular to this book are the many hints on the finer points of press tool design. Included also are the calculations of blank sizes with worked examples of areas for non-circular parts; and valuable information on different tool materials suitable for the many types of press tools with advice on their suitability for different conditions and quantities. The text is explained by numerous well executed line drawings, tables, and formulae; draftsmen, mechanical engineers, press tool designers as well as students will find the material interesting.

"High Temperature Technology—Materials, Methods and Measurements" edited by I. E. Campbell, has recently been published by John Wiley & Sons, Inc., New York. The book contains 526 pp., 6 x 9¼ in., is cloth bound, and sells for $15. It is sponsored by The Electrochemical

(*Please turn to page 254*)

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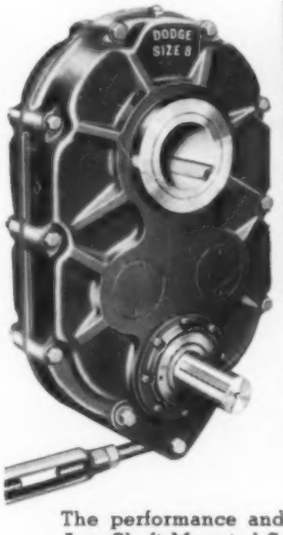

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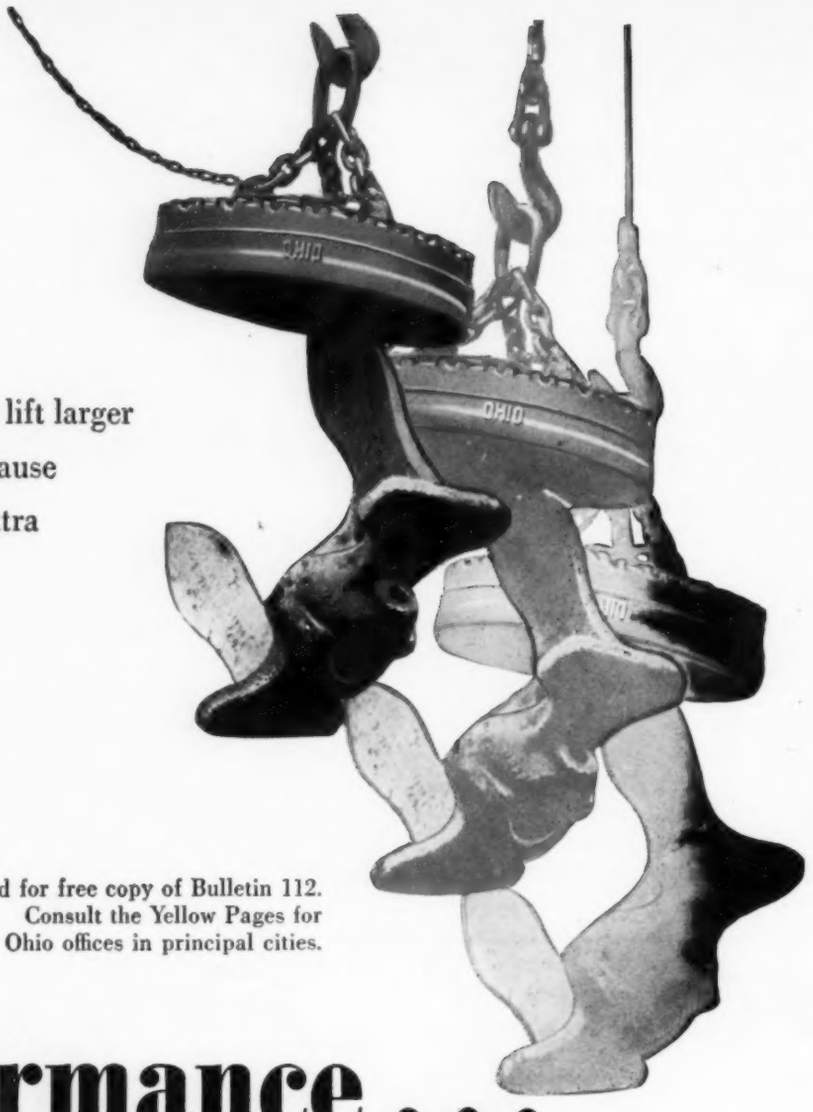

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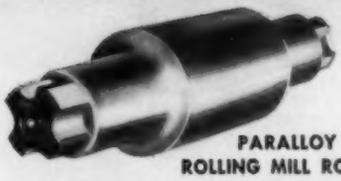

PARALLOY ROLLING MILL ROLLS
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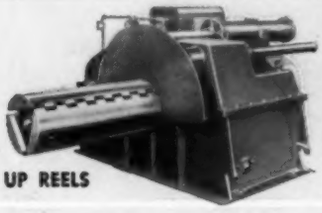
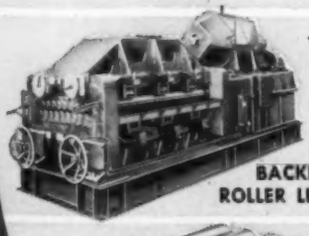
36" CONTOUR ROLL LATHE



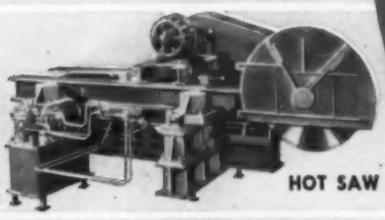
TAKE UP REELS

SLAB PUSHER

90" x 240" x ¼" STRETCHER LEVELER



BACKED UP ROLLER LEVELER



HOT SAW

DUCTILE RUN-OUT TABLE ROLLS

"Youngstown" Machinery serves major steel mills from coast to coast

"Youngstown" is well-known for its 70 years of experience in the designing, engineering and building of heavy, steel mill machinery. Pictures at left show a few examples . . . Complete lines—major units and auxiliaries. Additional "YF&M" products include ductile iron gears, rolls and castings up to 100,000 pounds.

"Youngstown" also builds extrusion presses and equipment for the "light metals" industry.

Modern Pickling Line cuts costs for western mill

Better pickling with less acid consumption . . . "Youngstown's" latest high speed continuous strip pickling line utilizes a new pull-thru type TRIPLE SCALE BREAKER that eliminates the need for a pinch roll stand.

Complete Scrubber Line built for midwest plant

This typical sheet scrubber line provides the ideal solution to the cleaning problem involving enamel sheet stock, dry or oiled stock, sheets for tin plating and special service sheets.

36" Contour Roll Lathe wins laurels for new improvements

Completely hydraulic tracer control insures smoother, more accurate finish. Featured improvements provide better turning, either on necks or centers. Built to suit specific needs.

Slitting Line speeds production for brass manufacturer

This complete 25" slitting line for brass and copper is giving "right-for-the-job" service. "Youngstown" has the correct answer for any slitting problem, whether it is .002" brass, copper, aluminum, or ⅜" steel plate.

Ductile Run-out Table Rolls excel in hot strip mill

Ductile cast iron rolls are reducing maintenance in leading mills. Especially good under the sprays. Resist heat check and breakage. Ductile iron is the ideal maintenance material for aprons, roller boxes, looper tables and looper rolls.

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Youngstown, Ohio

Y F&M

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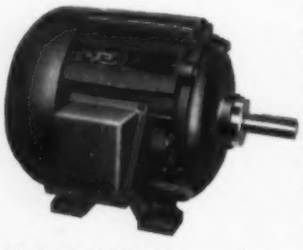
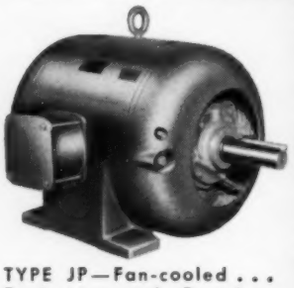
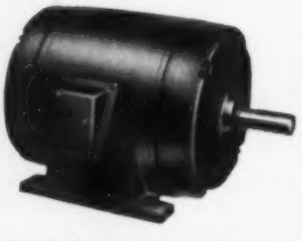


TYPE EP—Ribbed frame fan-cooled. New NEMA Frames. 1 to 30 hp.

TYPE EP—Totally-enclosed fan-cooled. Corrosion-resistant frames. 40 to 250 hp.

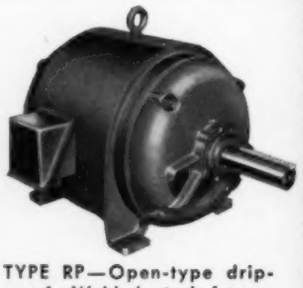


TYPE JP—Fan-cooled . . . Explosion-proof. Cast iron frames. 40 to 250 hp.



TYPE DP—Drip-proof . . . corrosion-resistant. New NEMA Frames. 1 to 30 hp.

TYPE DP—Drip-proof. Cast iron frames. 40 to 125 hp.



TYPE RP—Open-type drip-proof. Welded steel frames. 125 to 500 hp.

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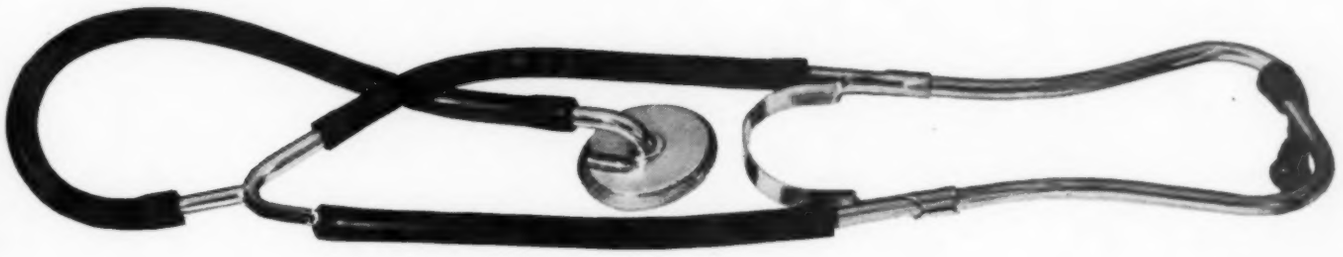
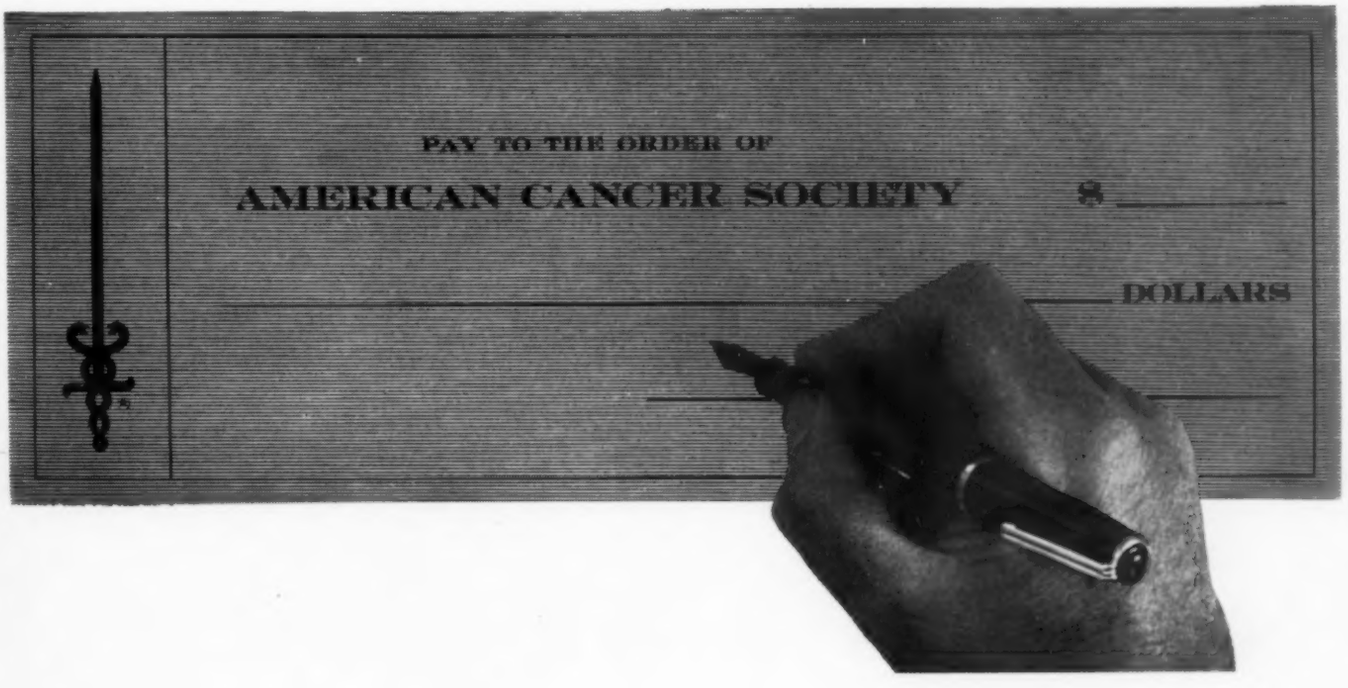
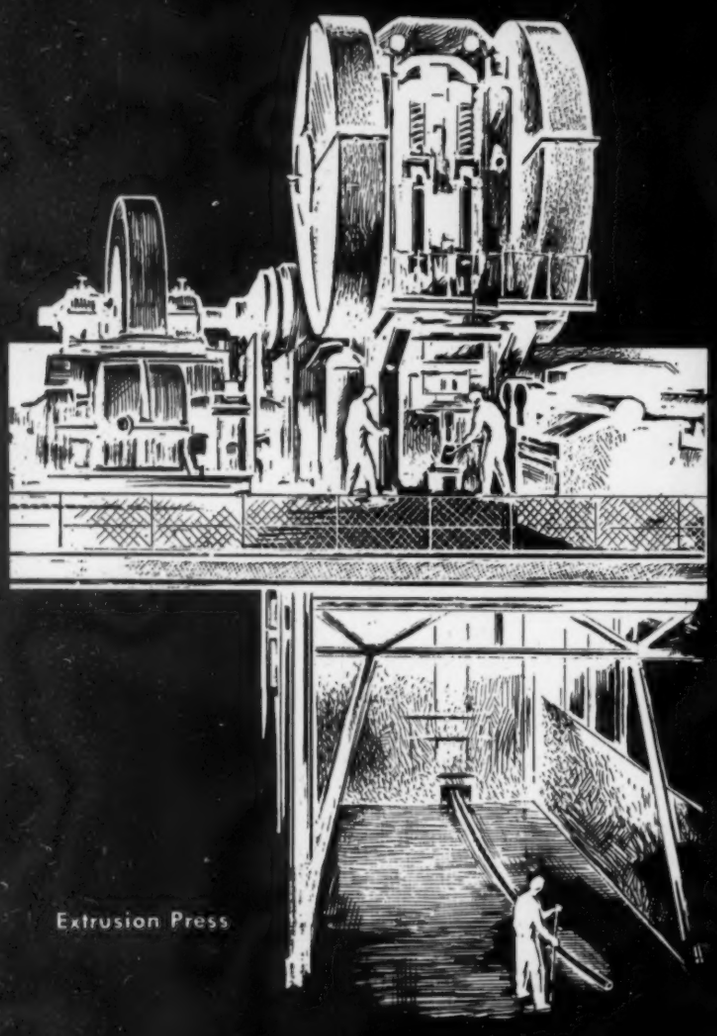


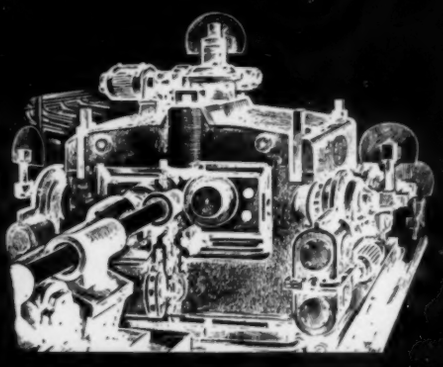
and a check

There has never been enough money to carry on all the research that needs to be done. Can you afford to remain indifferent to the enemy that strikes 1 out of every 4 Americans? Your donation—large or small—can help save lives. Someday, perhaps your own.

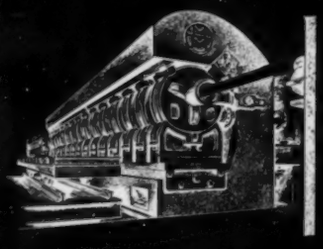




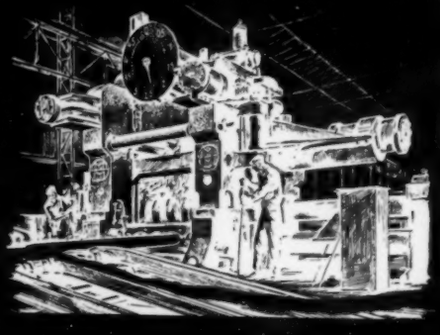
Extrusion Press



Reeler



Stretch Reducing Mill



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Whether your plans include the purchase of a single machine or a whole mill . . . Mannesmann-Meer can help you stay ahead in the race for high-speed tube production. You can obtain completely automatic operation of any tube-making process through Mannesmann-Meer engineering.

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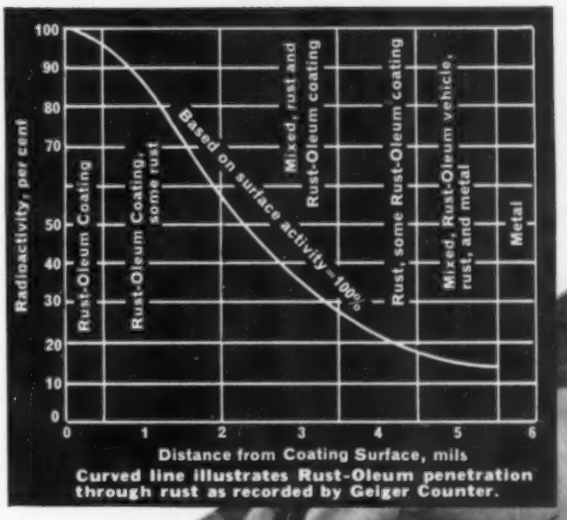
through rust to bare metal traced by Geiger Counter. To effectively stop rust—the vehicle of a protective coating, when applied over a sound, rusted surface—must penetrate through the rust down to bare metal. **Rust-Oleum does exactly that!—as proved by radioactive research!** Rust-Oleum's specially-processed fish oil vehicle was radio-activated and formulated into Rust-Oleum 769 Damp-Proof Red Primer—then applied to rusted test panels. Penetration *through rust* to bare metal by Rust-Oleum's specially-processed fish oil vehicle was then traced by Geiger Counter.

You stop rust, because Rust-Oleum's fish oil vehicle soaks deep down to bare metal and into the tiny pits where it drives out air and moisture that cause rust. You save, because this same *penetration* enables you to apply Rust-Oleum directly over rusted surfaces—usually eliminating costly surface preparations. Attach coupon to your letterhead for your thirty-page report entitled, "The Development of a Method To Determine The Degree of Penetration of a Rust-Oleum Fish-Oil-Based Coating Into Rust On Steel Specimens," prepared by Battelle Memorial Institute technologists.



Curved line illustrates Rust-Oleum penetration through rust as recorded by Geiger Counter.

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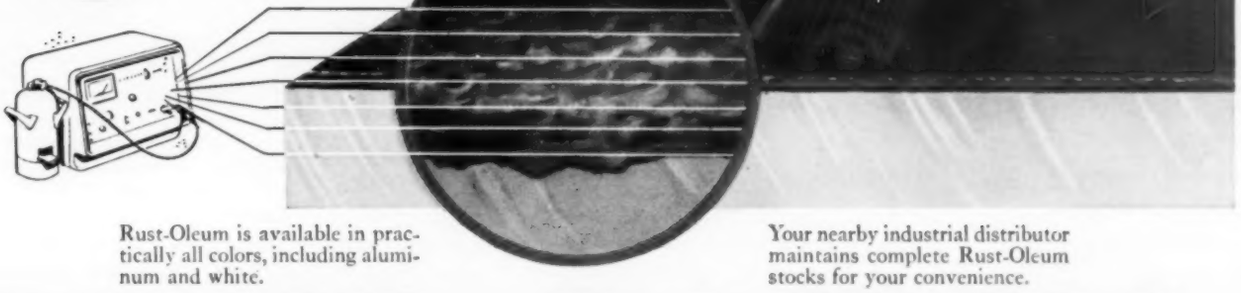

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NO ICE TODAY!
NO ACID BITE!

Keystone Aluminum Conductor System Brings Trouble-Free Service To Buffalo Plant

NIAGARA MOHAWK POWER COMPANY has ended a second winter without a shutdown of these coal storage towers. Another trouble-free record for KEYSTONE Aluminum Conductor Systems.

Service conditions are severe in the lake city. This outdoor installation formerly had a big ice problem with the original wire system, but ice can't form on the enclosed KEYSTONE inverted-V conductors. Sulphuric acid fumes from the coal piles won't corrode KEYSTONE's Aluminum Conductors, hangers and joint plates.

The KEYSTONE Integrated Aluminum Conductor System has installation advantages too. Lightweight, compact, easy to erect—an ideal system for the enclosure requirements of these leading towers.

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2. **LIGHTWEIGHT** aluminum permits pre-assembly of standard units; reduces installation costs and cost of insulators and supporting structures. Permits economical enclosures to safeguard personnel and operations.
3. **HIGH CURRENT CAPACITY,** low voltage drop. No need for boosters, multi-point feeds on long runways. Pre-engineered systems now operating up to 6,000 amp. capacity. Amperage possibilities unlimited.

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PHILADELPHIA 32, PENNA.

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A hydraulically operated clamping gag holds the work firmly on the saw side of the table, minimizing saw travel.

2-MOTOR DRIVE

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The saw feed is also hydraulic, and is adjustable as to speed and cutting pressure. Sawing cycle is completely automatic.

Birdsboro design features like these are helping other mills ease production headaches. For similar help in your own production operations, call in your Birdsboro representative.

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LASTS FAR LONGER than other materials.

REQUIRES FEWER REPAIRS on bottoms and banks, thus drastically reducing down-time and repair materials needed.

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"At Crown Zellerbach we have 24,000 employees who, like the company, have bills to pay, plans to finance, and emergencies to anticipate. This requires saving.

"Crown Zellerbach saves a portion of its annual income in U. S. Government securities. This saving is safe, systematic and, with interest, profitable. Our employees follow the same 'Good business' practice through the Payroll Savings Plan.

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J. D. ZELLERBACH, ***President***
Crown Zellerbach Corporation
Chairman, Committee for Economic Development
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BOOK REVIEWS

(*Continued from page 241*)

Society, and is a presentation of the work of 35 outstanding workers in the fields of metals engineers, metallurgists, ceramists, and chemists. Materials, methods, and measurement techniques are amply covered in the three divisions, and here is offered in succinct form the highlights of the research achievements to date that the groups have engaged in extensively in recent years. Many tables and graphic illustrations are used, and many references are cited.

"Directory American Council of Independent Laboratories, Inc.," was recently published in a sixth edition. This directory contains 98 pp, 6½ x 10 in., and is cloth bound. In addition to tabulations for the 67 member laboratories which provide details of facilities, book lists over 400 categories of available services. A geographical listing of members is included in the new edition. Also included is a code letter with each laboratory listing showing which laboratories perform specific functions in four geographical areas of the country. This handy reference may be obtained free of charge by writing on company letterhead to Mr. H. M. Dudley, Executive Secretary, American Council of Independent Laboratories, Inc., 4302 East-West Highway, Washington 14, D. C.

"Modern Surveying for Civil Engineers" by Harold Frank Birchal has recently been published by the Philosophical Library, 15 East 40th Street, New York 16, New York. The book contains 528 pages, 5¼ x 8½ in., is cloth bound and sells for $15.00. This second edition has been carefully revised and includes up to date descriptions and illustrations of the newer instruments and methods now available to the surveyor. Such modern methods as photographic and aerial surveys are discussed in detail, together with a refresher of all the preliminaries learned in college, the setting out required for bridges, tunnels, roads, etc., is clearly presented with appropriate diagrams. The book handles the subject of surveying in the practical and specialized manner required by the engineer engaged in the field or on a definite project.

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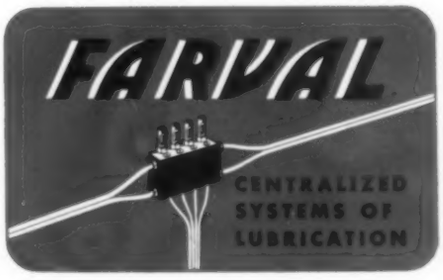

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